

CONNECTICUT RIVER FLOOD CONTROL PROJECT

SPECIFICATIONS

FOR CONCRETE FLOOD WALL AND EARTH DIKE

FISCAL YEAR 1940 UNIT

ITEM NO. C.3a (HIRED LABOR)

CHICOPEE, MASSACHUSETTS

NOVEMBER 15, 1939

CORPS OF ENGINEERS, U. S. ARMY

U. S. ENGINEER OFFICE

PROVIDENCE, R. I.

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WAR DEPARTMENT
UNITED STATES ENGINEER OFFICE
PROVIDENCE, R. I.

APPROPRIATION: Emergency Relief, 1938-1940.
21-3113 Flood Control, General.

EARTH DIKE AND FLOOD WALL ALONG CONNECTICUT RIVER
ITEM NO. C. 3a (HIRED LABOR)
CHICOPEE, MASSACHUSETTS

S P E C I F I C A T I O N S

SECTION I. GENERAL PROVISIONS

1-01. Location. - The site of the work covered by these specifications is located on the east bank of the Connecticut River, the south bank of the Chicopee River and west of the Boston and Maine Railroad in the west portion of the City of Chicopee, Massachusetts.

1-02. Work to be done. - a. The work provided for herein is authorized by the Emergency Relief Appropriation Act of 1938-1940, and by the Flood Control Act of June 28, 1938 (Public No. 761, 75th Congress).

b. The work to be done consists of furnishing all plant, labor and materials and performing all work required for constructing and repairing earth dikes, concrete flood walls, and appurtenant concrete structures, complete in accordance with these specifications, and the drawings forming a part hereof, together with such other incidental work at the site as may be required for completion of the work within the intent and scope of the specifications, or as may be ordered in writing by the District Engineer. It will consist of the following major items:

(1) Construction of an earth dike from station 5+65 to station 9+05 and from station 9+28 to station 16+29.

(2) Construction of a dumped rock toe along the river bank between station 0+00 and station 6+23+.

(3) Construction of new concrete flood walls complete with toe drains as indicated on the drawings between stations 0+00+ and 5+80.19, and riprapped bank from station 0+00+ to station 6+63.

(4) Construction of a stop-log structure at station 9+16.16.

1-03. Organization. - The work described in these specifications will be executed by the Area Engineer whose responsibility shall correspond to that of "contractor" as defined in Article 1, standard construction

contract form No. 23. The District Engineer as the officer responsible for the final accomplishment of the work specified will correspond to the "contracting officer."

1-04. Responsibility of the District Engineer. - a. The District Engineer will decide all questions which may arise as to performance, quantity and quality, acceptability, fitness and materials to be furnished and used, and the rate of progress of the work as described by these specifications and will decide all questions which may arise as to interpretations of the specifications and drawings.

b. Changes which are necessary due to changed conditions in the field and necessitate a change in the specifications or drawings will be made in writing by the District Engineer provided that any change involving an estimated increase or decrease of more than \$500 will be subject to the final approval of the Chief of Engineers, U. S. Army.

c. The work will be conducted under the general direction of the District Engineer and will be inspected by inspectors appointed by him. The organization of the inspection staff will be entirely separate from the Area Engineer's organization and will be directly responsible to the District Engineer. It is understood that any instructions given by the District Engineer through an inspector or other authorized employee are to be considered instructions or decisions of the District Engineer in all cases.

1-05. Description of project. - a. Dikes. - The dikes will be of the rolled earth fill type, totaling about 1,040 feet in length at the top elevation of approximately 72.6 feet mean sea level, with an average height of about 13 feet. The central and land-side portions of the dike will consist in general of random material. The river-side blanket and the cut-off will be constructed of selected impervious material. The slopes of the dike will be seeded and riprapped as indicated on the drawings. The top of the dike will be sodded and seeded. Crushed stone (or gravel) and tile drains will be installed to provide proper drainage on the land-side toe.

b. Walls. - (1) The new concrete flood walls will be constructed of reinforced concrete, totaling about 580 feet in length at the top elevation of approximately 70.6 feet mean sea level, with an average height above ground of 8.5 feet. These walls will be supported on concrete piles and will be provided with crushed stone (or gravel) and tile drains to provide proper drainage at the land-side toe. An impervious blanket will be placed on the river-side slope with a "Wakefield Type" timber sheet piling cut-off at the toe.

1-06. Drawings. - a. The work shall conform to drawings marked, "Chicopee Dike, Fiscal Year 1940 Unit, Chicopee, Massachusetts," as listed below, which drawings form a part of these specifications and are filed in the United States Engineer Office, Providence, Rhode Island.

<u>Sheet No.</u>	<u>Title</u>	<u>File No.</u>
1	Project Location and Index	CT-4-1995
2	Subsurface Explorations	CT-2-1196
3	Borrow Areas	CT-2-1197
4	General Plan	CT-4-1996
5	Plan and Profile No. 1	CT-4-1997
6	Plan and Profile No. 2	CT-4-1998
7	Dike and Riverbank Treatment Sections	CT-4-1999
8	Drainage Profile and Details	CT-4-2000
9	Concrete Wall Details No. 1	CT-4-2001
10	Concrete Wall Details No. 2	CT-4-2002
11	Steel Sheet Piling Plan and Profile, Stop-Log	CT-4-2003
12	Stop-Log Structure Concrete Details	CT-4-2004
13	Wall-Dike Junction, Scrap Pit Details	CT-4-2005
14	Sump Drain and Pressure Outlet Details	CT-4-2006
15	Turner's Falls Road Ramp	CT-4-2007
16	Stop-Log Structure, Steel Reinforcement No. 1	CT-4-2008
17	Stop-Log Structure, Steel Reinforcement No. 2	CT-4-2009
18	Concrete Wall, Steel Reinforcement No. 1	CT-4-2010
19	Concrete Wall, Steel Reinforcement No. 2	CT-4-2011
20	Steel Reinforcement Bar Schedule No. 1	CT-4-2012
21	Steel Reinforcement Bar Schedule No. 2	CT-4-2013

b. The work shall also conform to such other drawings relating thereto used in explanation of details or minor modifications as may be furnished by the District Engineer from time to time during construction.

1-07. Quantities. - The following estimate of net quantities is given to serve as an indication of the extent of the work covered by these specifications:

<u>Item No.</u>	<u>Designation</u>	<u>Unit</u>	<u>Quantity</u>
1	Preparation of site	acre	3.4
2	Stripping	cu. yd.	2,900
3	Common excavation, general	" "	3,900
4	Common excavation, cut-off trench	" "	2,700
5	Impervious borrow excavation	" "	20,900
6	Random borrow excavation	" "	30,900
7 (a)	Steel sheet piling	sq. ft.	5,120
7 (b)	Timber sheet piling	" "	8,700
8	Precast concrete piling	lin.ft.	4,152
9	Impervious fill, placing and rolling	cu. yd.	20,900
10	Random fill, placing and rolling	" "	30,900
11	Screened gravel	" "	2,020
12	Compacted backfill	" "	100
13	Semi-compacted backfill	" "	800
14	Riprap, hand-placed	" "	1,710
15	Dumped rock fill	cu. yd.	1,620
16	Grouted stone gutters	sq. yd.	30

Item No.	Designation	Unit	Quantity
17	Manholes	ea.	6
18 (a)	8-Inch V. C. tile pipe	lin. ft.	830
(b)	10-Inch V. C. tile pipe	" "	255
(c)	12-Inch V. C. tile pipe	" "	367
19	18-Inch V. C. pipe (bituminous joints)	lin. ft.	30
20	Flap valves		
(a)	10-Inch	job	1
(b)	18-Inch	"	1
21	18-Inch sluice gate complete with hoist and accessories		1
22	Cement	bbl.	1,520
23	Class "A" concrete in walls and stop-log structures	cu. yd.	1,190
24	Class "A" concrete in miscellaneous structures	" "	24
25	Steel reinforcement	lb.	121,874
26	Miscellaneous structural steel	"	344
27	Miscellaneous iron and steel	"	760
28	Copper water stops	"	290
29	Topsoil on embankment	cu. yd.	2,384
30	Sodding and seeding	acre	2.2
31	Timber stop-logs	M.F.B.M.	1.46
32	(Deleted, Item number retained.)		
33	Gravel surfacing for roads	cu. yd.	158
34	C. I. pipe with fittings		
(a)	10-Inch	lin. ft.	13
(b)	18-Inch	" "	24
35	Cleaning up	job	-

1-08. Physical data. - a. General. - Materials for constructing the earth dike are available in the vicinity of the work. Locations of borrow areas are shown on the drawings. Borings and test pits have been made in the vicinity of the proposed work with reasonable care and substantially at the places indicated on the drawings. Laboratory analyses have been made of the samples from many bore holes and test pits. Samples of the materials taken from them, and records of laboratory analyses and other studies may be seen at the United States Engineer Office, Providence, Rhode Island.

b. Transportation facilities. - (1) Railroads. - The Boston and Maine Railroad serves the City of Chicopee with main and branch line traffic, and adequate siding facilities are available in close proximity to the work. The Area Engineer shall investigate the availability of sidings, and make all arrangements with the railroad for any sidings necessary for delivery of materials and equipment to be used on the work, when necessary.

(2) Highways. - First-class highways also serve the city and there is reasonable access to all parts of the project. The Area Engineer shall construct and maintain all construction roads required, and investigate available roads for transportation, including load limits for bridges and roads, and any other road conditions affecting transportation of materials and equipment to the site.

c. Weather conditions. - The locality is subject to atmospheric temperatures ranging from minus 20 degrees to plus 105 degrees Fahrenheit. The mean annual precipitation at Chicopee is 43.62 inches. The mean monthly precipitation varies from a low of 3.20 inches in April to a high of 4.31 inches in July.

1-09. Lands, rights-of-way and damages. - a. The District Engineer will designate the lands, rights of way and easements which will be required for the project, and the Area Engineer shall undertake the construction only when directed by the District Engineer.

1-10. Removal of rubbish. - The Area Engineer shall keep the site free from rubbish. Suitable spoil areas for receiving refuse from the grounds shall be provided, and the rubbish shall be removed and disposed of as directed by the District Engineer and in a manner agreeable to the local interests and in accordance with the sanitary provisions of Paragraph 1-18. At the conclusion of the work, the site shall be cleaned up and all rubbish and unused materials shall be disposed of in accordance with Paragraph 11-05.

1-11. Datum and bench marks. - The plane of reference of Mean Sea Level as used in these specifications is that determined by the following bench mark:

T.B.M. #4

(U.S.C. & G.S.)

At Chicopee, Hampden County, about 100 yards south of the railroad station, at the southeast corner of the base of Semaphore #32. The top of an iron bolt. Elevation 81.332 feet M.S.L.

1-12. Lines, grades, stakes, and templates. - The Government inspector will define and approve on request all points and elevations reasonably necessary for the prosecution of the work from lines and grades established by the survey party.

1-13. Planimeter. - For the estimating of quantities in which computation of area by arithmetic and geometric methods will be comparatively laborious the planimeter shall be considered an instrument of precision adapted to the measurement of such areas unless otherwise directed by the District Engineer. Measurement of quantities in place after compaction will be used for cost keeping data.

1-14. Responsibility for work. - The Area Engineer shall be responsible for the work and take all precautions for preventing injury to persons and property on or about the work.

1-15. Borrow areas. - Borrow areas will be furnished by the local interests without cost to the Government, including rights of way for transportation purposes across property not owned. If sufficient material is not available in the borrow areas indicated on the drawings or otherwise provided to complete the work, additional areas will be furnished without cost to the Government.

1-16. Soil classification. - a. Soil classifications as referred to in these specifications conform to descriptive terms and limits of classifications as shown on Table No. 1, "Soil Classification," and Plate No. 1, "Diagram Showing Limits of Soil Classes," both of which form a part of these specifications.

b. Table No. 1 - Soil Classification.

(See page 7 for Table No. 1)

c. Plate No. 1 - Diagram Showing Limits of Soil Classes.

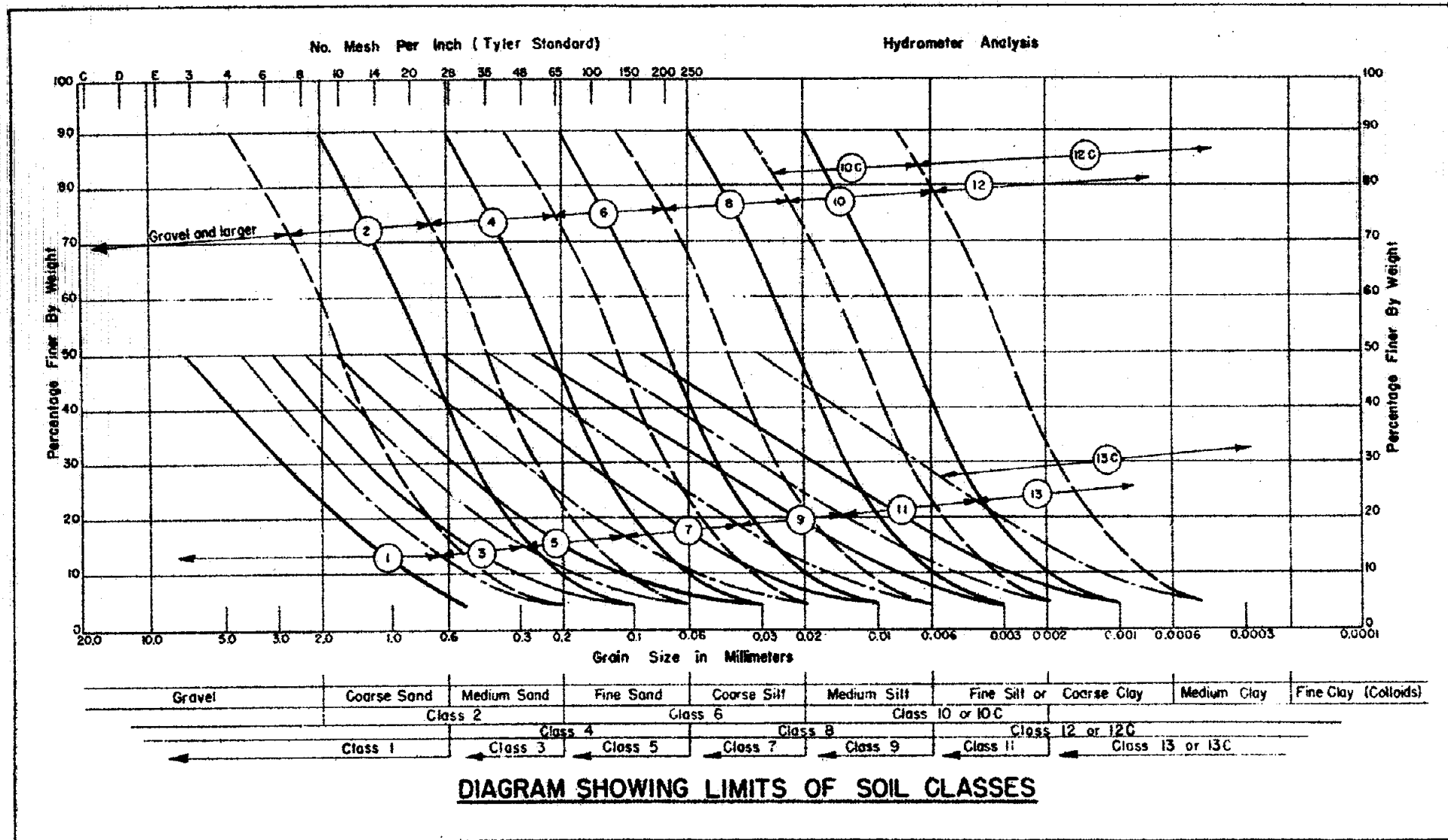
(See page 8 for Plate No. 1)

PROVIDENCE SOIL CLASSIFICATION
U. S. ENGINEER OFFICE
PROVIDENCE, R. I.

TABLE NO. 1

CLASS	DESCRIPTION OF MATERIAL
1	: <u>Clean Gravel.</u> - Contains little coarse to medium sand.
2	: <u>Uniform Coarse to Medium Sand.</u> - Contains little gravel and fine sand.
3	: <u>Variable - Graded from Gravel to Medium Sand.</u> - Contains little fine sand.
4	: <u>Uniform Medium to Fine Sand.</u> - Contains little coarse sand and coarse silt.
5	: <u>Variable - Graded from Gravel to Fine Sand.</u> - Contains little coarse silt.
6	: <u>Uniform Fine Sand to Coarse Silt.</u> - Contains little medium sand and medium silt.
7	: <u>Variable - Graded from Gravel to Coarse Silt.</u> - Contains little medium silt.
8	: <u>Uniform Coarse to Medium Silt.</u> - Contains little fine sand and fine silt.
9	: <u>Variable - Graded from Gravel to Medium Silt.</u> - Contains little fine silt.
10	: <u>Uniform Medium to Fine Silt.</u> - Contains little coarse silt and coarse clay. Possesses behavior characteristics of silt.
10C	: <u>Uniform Medium Silt to Coarse Clay.</u> - Contains little coarse silt and medium clay. Possesses behavior characteristics of clay
11	: <u>Variable - Graded from Gravel or Coarse Sand to Fine Silt.</u> Contains little coarse clay.
12	: <u>Uniform Fine Silt to Medium Clay.</u> - Contains little medium silt and fine clay (colloids). Possesses behavior characteristics of silt.
12C	: <u>Uniform Clay.</u> - Contains little silt. Possesses behavior characteristics of clay.
13	: <u>Variable - Graded from Coarse Sand to Clay.</u> - Contains little fine clay (colloids). Possesses behavior characteristics of silt.
13C	: <u>Variable Clay.</u> - Graded from sand to fine clay (colloids). Possesses behavior characteristics of clay.

PROVIDENCE DISTRICT SOIL CLASSIFICATION



1-17. Material purchased by the District Engineer. - All orders, shipping bills or memoranda accompanying material purchased by the District Engineer shall clearly indicate weights and shall be so worded or marked that each item, piece or member can be definitely identified on the drawings.

1-18. Liability and safety requirements. - a. The Area Engineer shall be responsible that his employees strictly observe the laws of the United States affecting all operations at the site under the project. He shall comply with all applicable Federal and state laws under which he is operating, including those concerning the inspection of boilers, hulls, and other equipment, the licensing of engineers, masters and other employees.

b. The Area Engineer shall conduct the work with due regard to adequate safety and sanitary requirements and shall maintain his plant and equipment in safe condition. He shall conform to current safety engineering practices as set forth in the Manual of Accident Prevention in Construction, Published by the Associated General Contractors of America; the publications of the National Safety Council, and with all applicable state or local safety and sanitary laws, regulations and ordinances.

c. The District Engineer will require such safety and sanitary measures to be taken as the nature of the work and the conditions under which it is to be performed, demand. Such measures include:

(1) The provision of adequate extinguishers or fire-fighting apparatus in and about all buildings and plant erected or used at the site of the work;

(2) Adequate first aid and life saving equipment;

(3) Adequate illumination during night operations;

(4) Watchman service at any railroad crossings, used by employees for access to the site;

(5) Warning lights between sunset and sunrise and during fogs, on all cofferdams, vessels, range piles and other obstructions placed in navigable waters during the progress of the work;

(6) Danger lights and barricades, in accordance with the laws of the State of Massachusetts, on all intercepted highways and on such obstructions and hazards which encroach on, or are adjacent to, public rights of way.

(7) Instruction in accident prevention to reach all employees;

(8) Such machinery guards, safe walkways, scaffolds, ladders, bridges, gang planks and other safety devices, equipment and apparel as are necessary to prevent accidents or injuries.

d. The Area Engineer shall report promptly to the District Engineer in Form prescribed by him all accidents occurring at the site of the work.

1-19. Use of explosives. - All blasting shall be done in the most careful manner so as not to endanger life, property, or the work. Explosives used shall be of a quality and power approved by the District Engineer. Dynamite in a frozen condition shall not be used. Approved explosives shall be stored before use in a suitable magazine, in an approved location, in compliance with state and local laws and regulations. Detonators shall be kept in a separate magazine not less than 100 feet from the explosives magazine. Magazines shall be plainly marked with large letters "EXPLOSIVES - DANGEROUS" and shall be kept locked. Accurate daily records shall be kept to account for each piece of explosive and detonator from the time of delivery at the magazine until its discharge in use.

1-20. Order of work. - The work covered by these specifications shall be commenced on the date designated by the District Engineer and shall be completed on or before June 30, 1940. The work shall be carried on at such localities and in such order of precedence as may be found necessary by the District Engineer. The location and limits of the work to be done will be plainly indicated by the District Engineer or his agents by stakes or otherwise. The District Engineer may suspend the work wholly or in part for such periods as he may deem necessary on account of conditions unfavorable for the suitable prosecution of the work.

1-21. Plant organization. - a. The Area Engineer shall provide sufficient plant of size suitable to meet the requirements of the work and shall maintain the plant and equipment in such condition as to perform the work efficiently and economically within the time specified. An ample force shall be maintained to conduct the work properly and efficiently.

b. No reduction in the capacity of the plant employed on the work shall be made except when approved by the District Engineer. The measure of the "capacity of the plant" shall be its actual performance on the work to which these specifications apply.

1-22. Employment of labor. - The method of employment, rate of wages, and monthly hours of employment for the various classifications of workmen shall be in strict conformity with the schedule (or any authorized revisions thereof) furnished by the Works Progress Administration for Chicopee. The District Engineer will report to the Department of Labor within five days after the close of each calendar month on forms to be furnished by the Department of Labor, the number of persons

employed on the project, the man-hours worked and the total expenditure for materials. No work shall be done on Sundays or on days declared by Congress as holidays for per diem employees of the United States except in cases of emergency, and then only with the written consent of the District Engineer. Night work, when necessary to maintain operating schedules will be permitted upon written approval of the District Engineer. (See Paragraph 1-20).

1-23. Purchase of supplies and materials. - a. Because the materials listed below, or the materials from which they are manufactured, are not mined, produced, or manufactured, as the case may be, in the United States in sufficient and reasonably available commercial quantities and of a satisfactory quality, their use in the work herein specified (subject to the requirements of the specifications) is authorized without regard to the country of origin:

Platinum	Nickel	Asbestos
Chromium	Rubber	China wood oil (tung oil)
Cork	Teakwood	Balsa wood
Jute	Silk	English ball clay
Kauri gum	Sisal	English china clay
Lac	Tin	Natural copper nickel alloy

b. Articles, materials, or supplies, manufactured in the United States and containing mercury, antimony, tungsten, or mica of foreign origin may be used (subject to the requirements of the specifications) in the work herein specified because such manufactured articles, materials, or supplies have been manufactured in the United States substantially all from articles, materials, or supplies mined, produced, or manufactured, as the case may be, in the United States.

1-24. Quality and inspection of supplies and materials. - a. All materials, supplies and articles used shall be, insofar as is practicable, the standard stock products of recognized and reputable manufacturers and shall be sufficient in strength, durability, usefulness and convenience for the purpose intended. All materials, parts and equipment shall be of the highest grade, free from defects and imperfections, of recent manufacture and unused. Workmanship shall be of the highest grade and in accordance with the best modern practice.

b. All materials, supplies, and parts and assemblies thereof, purchased for the work covered by these specifications, shall be inspected in conformity with modern approved methods as directed by the District Engineer. Unless waived in writing by the District Engineer, all tests and trials shall be made in the presence of a duly authorized representative of the District Engineer. When the presence of the inspector is so waived, sworn statements, in duplicate, of the tests made and results thereof shall be furnished the District Engineer by the supplier. All costs of all tests and trials excepting the expenses of the Government inspector shall be borne by the supplier and shall be included in the price bid.

1-25. Cost accounting. - a. The Area Engineer shall keep an accurate cost distribution record of all work done and shall submit a monthly cost report to the District Engineer. The cost shall be kept so that proper charges may be made against the items in Paragraph 1-07.

b. A separate account shall be kept of all labor charges in order that employees' compensation insurance may be determined.

c. The cost and expense of inspection and surveys shall be kept separately and not included in the actual cost of performing the work.

d. Prior to the commencement of the work, the Area Engineer shall prepare a Job Estimate Summary Sheet (Form No. 18 Costs) in quadruplicate and forward same to the District Engineer, attaching thereto the engineering estimate for performing the work. The final cost shall reflect all charges contemplated in the estimate.

e. Nothing in this paragraph shall be construed as changing the method by which costs are now reported in monthly and annual reports required by the cost keeping manual.

1-26. Protection of existing structures. - (1) During construction operations, on work covered by these specifications, the Area Engineer shall protect all existing structures and accepted work. Any disturbances or damage to any structures by operations under these specifications shall be repaired promptly by the Area Engineer without credit to the work.

(2) Care shall be taken to cause no interruption of service or other damage to the Boston & Maine Railroad because of construction operations adjacent to the railroad, as shown on the drawings or required by the District Engineer.

1-27. Final examination and acceptance. - As soon as practicable after the completion of any section of the work as in the opinion of the District Engineer will not be subject to injury by further operations under these specifications, such section may be examined as deemed advisable by the District Engineer. The District Engineer will make a thorough examination of same and if it is found to comply fully with the requirements of the specifications, it will be accepted.

SECTION II. PREPARATION OF SITE (Item 1)

2-01. Work included. - Clearing, grubbing, and disposal of materials shall be done as directed by the District Engineer, within the limits shown on the drawings or as staked in the field.

2-02. Clearing. - a. The areas to be cleared shall be as required (see Paragraph 2-01) within the following classifications: (1) The area within the limits of the foundation of the required earth dike, together with a 5-foot strip measured horizontally beyond and contiguous to the toe line on each side of the dike, (2) borrow areas, (3) the areas within the limits of the foundations of the required concrete flood walls or other structures, (4) the river bank, and (5) any other areas designated by the District Engineer within the limits shown on the drawings.

b. Trees and other obstructions shall be removed by the Area Engineer from the sites of the proposed structures and of the borrow areas when and as directed by the District Engineer. All trees with a diameter of 12 inches or larger shall be removed from the river bank and may be removed from other areas only to the extent directed or permitted. The Area Engineer shall preserve and protect from injury all trees not required to be removed.

c. All timber, undergrowth, brush, logs, weeds, and debris of any nature which, in the opinion of the District Engineer are unsuitable for foundations of the dikes and flood walls, shall be removed to such depths as directed by the District Engineer.

2-03. Grubbing. - a. The areas to be grubbed shall include the foundation areas for the dike and wall and other areas as may be directed by the District Engineer.

b. All such areas shall be thoroughly grubbed of all stumps, roots, buried logs and other objectionable matter. Tap roots and other projections over 1-1/2 inches in diameter within the limits of the dike and flood wall foundations, shall be grubbed out to a depth at least 3 feet below the foundation surface, unless otherwise directed by the District Engineer. Old road beds shall be thoroughly broken up or removed as directed by the District Engineer.

2-04. Removal of structures. - The removal of existing structures and utilities required to permit the orderly prosecution of the work covered by these specifications shall be accomplished by local agencies in a manner as directed by the Area Engineer and satisfactory to the District Engineer. Whenever a telephone or telegraph pole, pipe line, conduit, sewer or other utility is encountered and must be removed or modified to permit completion of the work, the District Engineer will notify the proper local authorities, who shall take action to have the designated utility promptly removed.

2-05. Disposal of materials. - All materials removed, as specified above, shall be disposed of by burning or by removal to approved disposal areas as directed. No material shall be thrown into, or left along the bank of the river. The disposal of material shall closely follow the operations of clearing and grubbing. Material shall not be placed on land adjacent to the construction area except as directed by the District Engineer. No damage of any nature shall be inflicted upon adjoining property owners by unwarranted entry or disposal of material on adjacent property.

2-06. Credit. - Credit for all work in connection with the preparation of the site as hereinbefore specified, including the loading, hauling, and disposal of the materials, will be made by the acre under Item 1, "Preparation of Site." Only the acreage actually cleared as directed will be included in the measurement for credit.

SECTION III. EXCAVATION (Items 2 to 6 incl.)

3-01. Classification. - All materials excavated will be classified as follows:

a. Common excavation shall include all earth, clay, sand, gravel, and topsoil as defined below, also such hard and compact materials as hardpan, cemented gravel, shale and soft or disintegrated rock that can be removed by hand, power shovels, or draglines without continuous and systematic blasting, and also all boulders and detached pieces of solid rock.

b. The words "soil" or "topsoil" shall mean the material composing the surface layers of the ground containing varying amounts of organic matter.

c. Detailed classification is as follows:

(1) Stripping (Item 2) (see Paragraph 3-02).

(2) Common Excavation (see Paragraphs 3-03, 3-04, and 3-05).

General (Item 3).

Cut-off Trench (Item 4).

Borrow Areas (Items 5 and 6).

3-02. Stripping (Item 2). - a. Work included. - (1) The Area Engineer shall strip the area specified herein or directed by the District Engineer to the depths indicated on the drawings or required, not exceeding a maximum of 3 feet, to remove all materials not suitable for the foundation of the dike as determined by the District Engineer. The unsuitable materials to be removed shall include sod, topsoil, rubbish below the ground surface not removed by clearing and grubbing, all loose, weathered or otherwise unsatisfactory rock and any other objectionable material.

(2) Topsoil and sod obtained from the stripping operations shall be stockpiled in an approved location to be used later in dressing earth dike slopes, unless otherwise authorized by the District Engineer.

b. Description. - The areas occupied by the earth dike and river bank protection shall be stripped to the minimum depth shown on the drawings.

c. Disposal of materials. - The Area Engineer shall deposit suitable excavated materials in the required embankments as directed by the District Engineer, and shall waste in spoil banks in approved locations materials from the excavation that are unacceptable for use in the embankments as directed by the District Engineer.

Materials which cannot be placed at once in permanent positions, may be deposited in storage piles at locations designated. The materials to be excavated from such storage piles will not again be credited as excavation.

d. Measurement and credit. - Measurement will be made of the volume in place before excavation, for the amount of material actually removed to the specified lines and grades or as directed by the District Engineer. Credit for all work in connection with stripping, including the loading, hauling, and disposal of the materials, will be made by the cubic yard under Item 2, "Stripping."

3-03. Common excavation - general and cut-off trench (Items 3 and 4). - a. Work included. - Under Item 3, the Area Engineer shall excavate and dispose of the materials classified as common excavation-general above and below the mean water level in the river to the lines and grades shown on the drawings for the respective areas, or as otherwise directed by the District Engineer. Common excavation-general includes excavation for the foundation of the earth dike additional to that included under Items 1 and 2, and any other required common excavation for structures, ditches and gutters not included in other items of the work. Under Item 4, the Area Engineer shall excavate and dispose of all materials encountered in the cut-off trench and drains, and not included in other items of the work.

b. Description. - Excavation will be performed in accordance with a schedule of operations to be approved by the District Engineer. The required depth of the cut-off trench at all points cannot be known with certainty until the area is fully developed by the construction operations. The ordered lines and grades shall include any necessary adjustments to field conditions.

c. Pumping and draining. - The Area Engineer shall do all pumping and draining necessary to perform the excavation in the dry, and to keep the cut-off trench unwatered until it has been satisfactorily backfilled with suitable material.

d. Disposal of materials. - As directed by the District Engineer all suitable materials excavated under Items 3 and 4 shall be placed in the earth dike or miscellaneous fills. Excavated materials not used in such construction may be used by the Area Engineer in temporary construction if approved by the District Engineer or shall be disposed of otherwise in designated spoil areas as provided in Paragraph 3-02 c.

e. Measurement and credit. - See Paragraph 3-05.

3-04. Common excavation - borrow areas (Items 5 and 6). - a. Work included. - The Area Engineer shall excavate under Items 5 and 6 in the indicated borrow areas or other approved areas, the materials to be used in the dike, or miscellaneous fills. Excavation shall include the transportation of the material to the point of disposal. Borrow excavation

shall include the stripping of the areas and disposal of objectionable topsoil containing roots or other debris, and the removal and the disposal of any other objectionable material so designated by the District Engineer. To provide suitable fill materials excavations shall be made to the depth and in the locations directed by the District Engineer. After completion of excavation the borrow areas shall be so graded that the surfaces shall blend into the surrounding topography and so that all surface water will readily drain from them. The borrow areas shall be left in a neat and sightly condition satisfactory to the District Engineer.

b. Description. - Under Items 5 and 6 shall be included the excavation from the borrow area as shown on the drawings. The limit of excavation in the vicinity of the earth dike shall be as directed by the District Engineer.

c. Disposal of materials. - The provisions of Paragraph 3-03 d shall apply.

d. Measurement and credit. - See Paragraph 3-05.

3-05. Measurement and credit. - (a) Measurement for excavation work under Items 3 to 6, inclusive, will be by the cubic yard for the amount of material actually removed to the lines and grades shown on the drawings or as established by the District Engineer. Quantities will be measured in place before excavation (see Paragraph 5-13 b). Credit for all work in connection with excavation under Items 3 to 6, inclusive, including the loading, hauling, and disposal of the materials, and all required sheeting and shoring, will be made by the cubic yard under Items 3, 4, 5 and 6, as applicable, for the several items of excavation (see Paragraph 1-07).

(b) Measurement for excavation under Item 3, "Common Excavation - General," and Item 4, "Common Excavation - Cut-Off Trench," will be for the amount of material actually removed to the required lines and grades additional to the amounts included under Items 1 and 2 (see Paragraph 3-03 a).

(c) Measurement for excavation under Items 5 and 6, "Common Excavation - Borrow Areas," will be for the amount of material actually removed to the required lines and grades, except that any required surface stripping of the borrow areas to a maximum depth of 3 feet will not be included in such measurement.

SECTION IV. PILING (Items 7 and 8).

4-01. Classification. - Piling shall be classified as follows:

- a. Steel sheet piling (Item 7 (a)) (see Paragraph 4-02).
- b. Timber sheet piling (Item 7 (b)) (see Paragraph 4-03).
- c. Precast concrete piling (Item 8) (see Paragraph 4-04).

4-02. Steel sheet piling (Item 7 (a)). - a. Work included. - The Area Engineer shall construct the steel sheet-piling cut-off under the stop-log structures as shown on the drawings. The cut-off shall be constructed of piles of varying lengths, including specials, driven to grade, between the limits as shown on the drawings. Care shall be taken to avoid damage to existing utilities encountered in the work.

b. Type and properties. - Unless otherwise shown on the drawings the piles for the cut-off under Item 7 (a) shall be of an approved commercial type and shall have a minimum thickness of metal of $3/8$ inch, except that a reasonable reduction for shaping the joints of the interlock will be permitted. The piles shall provide a section modulus of not less than 5.4 inches cubed per linear foot of cut-off, and shall weigh not less than 22 pounds per square foot of cut-off, exclusive of any welded or riveted connection or reinforcement. The interlocked joints shall develop a strength in direct tension of not less than 8,000 pounds per linear inch of interlock without rupture. The piles shall be continuously interlocked throughout their entire length and shall be provided with standard pulling holes. The type and dimensions of the piles the Area Engineer proposes to furnish shall be submitted to the District Engineer for approval before any piles are delivered to the work.

c. Material. - Steel for sheet piling shall conform to Federal Specification QQ-S-751A for "Steel: Structural (including Steel for Cold Flanging) and Steel: Rivet (for) Ships other than Naval Vessels," Structural Grade, except for the following requirements:

(1) Tensile strength shall be not less than 70,000 pounds per square inch, except that fabricated sections such as corner piles, tee piles and other special sections shall be of steel having a tensile strength of not less than 60,000 pounds per square inch.

(2) Elongation in 8 inches, percent minimum $\frac{1,400,000}{\text{tensile strength}}$.

(3) Bend test specimens shall withstand bending 180 degrees around a pin with a diameter twice the thickness of the specimen without fracture on the outside of the bend.

d. Driving. - The piles shall be driven to form a continuous interlocking diaphragm down to rock or to the elevation established for the bottom of the cut-off as shown on the drawings. A protecting cap shall

be used in driving. The hammers shall be of a suitable size and type, either steam or air operated. The use of a water jet may be permitted at the discretion of the District Engineer. Piles shall be driven without injury to them, true to line and grade, and shall be cut-off, where necessary, to the top elevation of the sheet-piling cut-off as shown on the drawings. Proper precautions shall be taken to prevent rupture at the interlocks. Piles ruptured at the interlock or otherwise injured shall be removed and replaced by new piles.

e. Measurement and credit. - The quantity of steel sheet piling to be credited will be the number of square feet of sheet piling actually in place as specified below the top elevation of the sheet-piling cut-off. Credit will be made by the square foot under Item 7 (a), "Steel Sheet Piling", and shall include the costs of all labor, materials, equipment and incidentals required to construct the sheet-piling cut-off as specified.

4-03. Timber sheet piling (Item 7 (b)). - a. Work included. - The Area Engineer shall furnish all labor, material, and equipment and do all work required to install the "lakefield" type, permanent timber sheet piling, in structure foundations at locations and in accordance with the details as shown on the drawings or as directed by the District Engineer. The timber sheet piling shown on the drawings shall be constructed only to the extent specifically directed by the District Engineer to cut off any pervious stratum at the river-side toe of the impervious blanket as disclosed during construction.

b. Materials. - The sheet piling shall be of the dimensions shown on the drawings. Timber for wales and braces not shown on the drawings shall be of economical dimensions, acceptable in modern practice. All timber used shall be No. 1 Structural Grade, Southern Yellow Pine, S4S, and shall meet the approval of the District Engineer. Nails and other hardware shall conform to current standard practice for the material required and use intended.

c. Installation. - The sheeting shall be driven as true as possible to the lines and grades shown on the drawings, without injury to the piling, and shall be cut-off, where necessary, to the top elevation as shown on the drawings. Necessary wales and bracing shall be installed as shown on the drawings or directed by the contracting officer.

d. Measurement and payment. - The quantity to be credited will be the number of square feet of timber sheet piling actually in place as specified below the top elevations shown on the drawings. Credit will be made by the square foot under Item 7 (b), "Timber Sheet Piling," and shall include all costs of furnishing and installing the piling.

4-04. Precast concrete piling (Item 8). - a. Work included. - The Area Engineer shall furnish all labor, material, and equipment, and do all work required for driving precast concrete piling in structure foundations at the locations shown on the drawings.

b. Materials. - The concrete piling shall be of reinforced concrete and of the dimensions and shape as shown on the drawings, or as approved by the District Engineer. The concrete shall conform to the

requirements of Section VIII for Class "A" concrete. The reinforcing steel shall conform to the provisions of Paragraph 8-18 b.

c. Driving. - The piles shall be driven with an air or steam hammer of suitable size and type to properly drive the piles. If necessary to prevent damage to the pile heads, a suitable cushion shall be provided. Piles shall be driven plumb to a tolerance of 1/4-inch per foot of length. After being driven, the top ends of all concrete piles shall be cut-off to the elevation of the tops of piles as shown on the drawings. If any piles are raised by the subsequent driving of others, they shall be redriven. Piles injured by driving, or those driven out of place shall be pulled out and replaced by new piles. Piles shall be of the full length required and lengthening by means of splices or butt joints will not be permitted.

d. The bearing capacity shall be determined by the following formulas:

$$P = \frac{2 WH}{S + 0.1} \quad \text{for single acting steam hammer}$$

$$P = \frac{2 E}{S + 0.1} \quad \text{for double acting steam hammer}$$

Where P = loads in pounds, W = weight of falling hammer in pounds, H = height of fall in feet, S = average penetration in inches per blow for the last few blows (5 to 10 blows for single acting hammers and 10 to 20 blows for double acting hammers). E = energy in foot pounds per blow as listed by the manufacturer for the given number of strokes per minute.

The above formulas are applicable when:

- (1) The hammer has a free fall.
- (2) The penetration is at a reasonably quick and uniform rate.
- (3) There is no appreciable bounce after the blow. Twice the height of the bounce shall be deducted from "H" to determine its true value in the formula.

The hammer shall be of such size and capacity that the indicated bearing capacity of the pile calculated by the above formulas, when S = zero, shall be not less than 45 tons.

e. Measurement and credit. - The quantity to be credited under Item 8 will be the number of linear feet of concrete piling satisfactorily placed below the elevation of the cut-off as shown on the drawings, and shall include the costs of tests made on the piles. The measurement of quantity will be made after cut-off. Credit will be made under Item 8, "Precast Concrete Piling", and shall include all costs of furnishing and installing the piling.

SECTION V. EARTH DIKE (Items 9 and 10).

5-01. Definitions. - The term "embankment" as used in these specifications includes earth fill of all types for the earth dike and cut-off trench, and all other specified or directed earth fills within the limits shown on the drawings. The various types of earth fill are "impervious" under Item 9, for the cut-off trench and the blanket on the riverside of the embankment as shown on the drawings; and the "random" under Item 10, required where shown on the drawings.

5-02. Work included. - The Area Engineer shall grade and consolidate materials required for the embankment, to the elevation, lines, grades and cross sections shown on the drawings, with such increased height and width as may be deemed necessary by the District Engineer to allow for later shrinkage or settlement. The Area Engineer shall use suitable materials as approved by the District Engineer.

5-03. Materials. - a. General. - All materials from required excavations will be used in the embankment, if, as excavation proceeds, they are found suitable by the District Engineer. Brush, roots, sod, any type of organic materials, and other perishable or unsuitable material as determined by the District Engineer shall not be placed in the embankment. Materials shall not be wasted except by specific instructions from the District Engineer.

b. Borrow. - Other suitable materials shall be borrowed from locations shown on the drawings in accordance with Paragraph 3-04. The origin of any material from either structure or borrow excavations does not definitely determine where it will be used in the embankment. Materials from two or more excavation or borrow areas may be required to be used at the same time and in the same part of the embankment, mixing being done in the process of placing by systematic dumping, spreading and bulldozing. Materials from one area may be required to be used in different parts of the embankment.

c. Test requirements. - The various types of earth fill defined in Paragraph 5-01 shall conform to the test requirements and approved classification established by the Soils Laboratory, U. S. Engineer Office, Providence, R. I.

5-04. Plowing. - Immediately prior to the placing of materials in the embankment, and after stripping has been completed (see Paragraph 3-02), the entire foundation of the embankment shall be thoroughly plowed and broken to a depth of 4 inches. The furrows shall run approximately parallel to the axis of the embankment. All roots, stones, and debris or other objectionable material shall be removed and disposed of, as directed by the District Engineer. The condition of the surface material of the foundation area at the time of plowing shall be slightly drier than the required moisture content for rolled embankment. The requirements for plowing do not apply to the side slopes of the cut-off trench, and

stump holes. Plowing shall be completed not less than 200 feet in advance of the embankment. After plowing, the entire surface of the foundation area shall be rolled in accordance with Paragraph 5-06 d.

5-05. Filling of excavations in embankment area. - a. General. - The cut-off trench, test pits, stump holes, and other excavated areas within the limits of the embankment and as otherwise shown on the drawings shall be filled with random or impervious materials in the dry as directed by the District Engineer. The fill shall be placed in layers, moistened, and rolled in accordance with Paragraph 5-06 whenever, in the opinion of the District Engineer it is possible to do so. Material which cannot be compacted by roller equipment on account of clearances, shall be spread in 4-inch layers and compacted with hand or power tampers which shall give the degree of compaction required for the embankment. As the fill is brought up, the side slopes of the cut or hole shall be scarified by equipment or by hand if necessary to provide a bond between the fill and the original ground material (see Paragraph 5-06 d (2)).

b. Stump holes. - The sides of stump holes shall be broken down with bulldozers or a disc harrow so as to flatten the slopes, and the hole then filled with approved material and properly rolled or tamped in place.

c. Cut-off trench. - The fill for the cut-off trench shall be placed in the dry and rolled in accordance with Paragraph 5-06. The water shall be drained to a sump and removed by pumps. The fill shall be made by working the materials toward the sump and sloping the surface of the fill longitudinally toward the sump. Well points may be used for drying up the foundation when approved by the District Engineer.

5-06. Rolled fill. - a. General. - The impervious and random sections of the embankment shall be constructed with a crown running with the center line of the dike and with slopes approximately on a 2 percent grade toward the edges of the embankment. This slope shall be maintained until the completion of the embankment, thus bringing up together the impervious and random sections, unless otherwise directed by the District Engineer. As soon as practicable, the embankment shall be brought to a nearly uniform grade for the entire length.

b. Furnishing and placing. - (1) The Area Engineer may use power shovels, draglines, or any type of excavating machinery which is capable of excavating the materials in dry condition. The Area Engineer may use any approved method of transporting materials in natural dry condition. The dumping of the successive loads shall be at locations as directed by the District Engineer. When two or more different materials are being moved into a section of the embankment they shall be spotted and dumped systematically so that in any area of the section there are approximately the required proportions of the materials. After dumping, the materials for the impervious section shall be bulldozed or otherwise spread in approximately 8-inch layers and rolled (see Paragraph 5-06 d). The random materials shall be spread in layers approximately 12 inches in thickness as determined by the District Engineer and rolled (see Paragraph 5-06 d).

Should the material for the various sections of the embankment be too high in water content when dumped, it shall be bulldozed or otherwise spread and harrowed and left for a sufficient time to allow the surplus water to dry out before being rolled. If, in the opinion of the District Engineer, the rolled surface of any layer of the materials is too smooth to bond properly with the succeeding layer or, if the materials have dried out sufficiently to cause cracks in the surface, it shall be roughened or loosened by a disc harrow, or other approved means, and dampened, if required, before the succeeding layer is placed thereon. All roots, trash, and debris shall be promptly removed from the embankment and disposed of to the satisfaction of the District Engineer. Stones greater than 6 inches in diameter shall be removed from the impervious and random sections and when approved by the District Engineer shall be placed in the section of the embankment immediately above the toe drain. The entire surface of the embankment shall be maintained in such condition that construction equipment can travel thereon. Routing of construction equipment on the embankment shall be subject to direction by the District Engineer.

(2) Any embankment material lost or loosened, after being placed in the embankment and before the completion and acceptance of the completed work, because of any operation of the Area Engineer or for other causes that in the opinion of the District Engineer were avoidable or under the control of the Area Engineer, shall be replaced by the Area Engineer without credit to the work to the satisfaction of the District Engineer.

(3) The Area Engineer shall cease work on the embankment at any time when satisfactory work cannot be done on account of rain, high water, cold weather, or other unsatisfactory conditions.

c. Moisture control. - To obtain the desired degree of compaction for the varying kinds of material used, the moisture content of the material being placed shall be the optimum required for satisfactory compaction, as determined by the District Engineer. If required, the compacted surface shall be sprinkled as directed immediately before placing each new layer. The moisture content shall be sufficient to dampen the fill materials as required, but the amount of sprinkling shall be controlled so that no free water will appear on the surface during or subsequent to the rolling. An adequate supply of water shall be available. Jets shall not be directed at the embankment material with such force that the finer materials are washed out.

d. Compaction. - (1) Tamper type roller. - Rolling for the impervious section of the embankment shall be done by a tamper type twin roller such as a "sheeps-foot" roller, water or sand ballasted, having tamping feet uniformly staggered over its cylindrical surface, and equipped with cleaners; or other satisfactory type of tamper roller as approved by the District Engineer. Each tamping foot shall project approximately 7 inches from the roller's cylindrical surface and shall have a face area of not less than 5 and not more than 7 square inches. The spacing shall be such as to provide a minimum of two tamping feet

for each square foot of cylindrical surface. Addition or reduction in the number of tamping feet shall be made when directed by the District Engineer. The total weight of the roller in pounds divided by the total area of the maximum number of tamping feet in one row parallel to the axis of the roller shall be not less than 115 pounds per square inch with the drum empty, and not less than 200 pounds per square inch with the drum ballasted. The design and operation of the tamping roller shall be subject to the approval of the District Engineer.

(2) Rolling impervious section. - When the moisture content and condition of the spread impervious layers of the embankment are satisfactory to the District Engineer, the Area Engineer shall roll the impervious section of the embankment with tamper type twin rollers. Each set of twin rollers shall be pulled by a crawler type tractor of suitable power weighing not less than 20,000 pounds, manufacturer's standard weight, at a speed of approximately 2-1/2 miles per hour. Each square foot of each layer of the embankment material shall be compacted by not less than six passes of the rollers for the impervious fill. Additional passes of the rollers shall be made if necessary to obtain the required compaction. Successive trips of rollers shall overlap by at least 2 feet. Failure to comply with this requirement for careful rolling will be a cause for additional trips. Where new material abuts old material, either in place or in embankment, the old material shall be cut or broken by machine or hand methods approved by the District Engineer, until it shows the characteristic colors of undried materials, and the rollers shall work on both materials, bonding them together. Portions of the earth fill which the roller cannot reach for any reason shall be thoroughly compacted in 4-inch layers by tamping with hand or power tampers. The degree of compaction for such portions of the earth fill shall be equivalent to that obtained by sprinkling and rolling as specified for the other portions of the earth fill.

(3) Rolling random section. - Rolling of the random section of the embankment shall be the same as specified above except that a minimum of 3 passes of the roller will be required. If, in the opinion of the District Engineer, better compaction can be obtained by the use of a plain cylindrical roller, or a Parson's disc tamping roller, the use of such a roller may be required. The disc tamping roller shall weigh not less than 1,100 pounds per linear foot. When conditions of the work so require, at the direction of the District Engineer, rolling may be done by a crawler type tractor weighing not less than 20,000 pounds; in such cases a maximum of four passes of the tractor treads on each square foot of embankment area will be required.

(4) Tests for compaction. - Samples of all embankment materials for testing, both before and after placing and compaction, will be taken at frequent intervals under the supervision of the District Engineer. Corrections, adjustments, modifications of methods, selection of material and moisture content will be made from these tests to secure the maximum density of the materials in the embankment (see Paragraph 5-03 c).

e. Impervious fill. - Impervious fill shall be selected and secured from required excavations and borrow areas as directed by the District Engineer, and shall be placed in the impervious section of the embankment throughout the entire length.

f. Random fill. - Random fill shall be selected and secured from required excavations, stockpiles and borrow areas as directed by the District Engineer, and shall be placed in the random section of the embankment in the locations shown on the drawings. This material shall be placed so that the finer particles are near the impervious material in order that a gradational transition be effected. The coarser materials from the random borrow areas shall be selected and reserved for use in that part of the random fill which is adjacent to the toe drain as shown on the drawings and elsewhere as directed.

5-07. Removal of objectionable material. - The Area Engineer shall, when directed by the District Engineer, excavate, remove and dispose of any material from the embankment sections which the District Engineer considers objectionable in such locations, and refill the area as directed in accordance with Paragraph 5-05.

5-08. Slides. - In case of slides in any part of the embankment during the construction or after completion, but prior to the final acceptance of the work, the Area Engineer shall cut out and remove the area specified by the District Engineer and then rebuild the excavated area in accordance with these specifications.

5-09. Frozen materials. - No earth shall be placed upon a frozen surface, nor shall frozen earth, snow or ice be placed in the embankment. In cases of emergency the District Engineer may require frozen material to be stockpiled for later use in the embankment.

5-10. Shrinkage or settlement. - Excess embankment material required by shrinkage or settlement during construction will not be measured in so far as credit for fill in embankment is concerned. Excavation of excess materials from the borrow areas required by settlement and shrinkage will be credited to the work at the applicable credit item for excavation.

5-11. Temporary drains and ditches. - The Area Engineer shall maintain the site of the work and the grounds immediately adjacent thereto, free from collected surface water if, in the opinion of the District Engineer, such collected water affects the safety or condition of the work. Such temporary drains and ditches shall be constructed as are deemed necessary and directed by the District Engineer.

5-12. Topsoil and sodding. - a. Placing topsoil. - Unless otherwise authorized by the District Engineer, a suitable topsoil shall be placed on the slopes and top of the earth dike, as shown on the drawings. Credit for placing topsoil will be made under Item 29 (see Paragraph 11-01 e).

b. The areas upon which topsoil has been placed shall be sodded and seeded as specified in Paragraph 11-01. Credit for sodding and seeding will be made under Item 30. Measurement and credit will be made as specified in Paragraph 11-01 e.

5-13. Measurement and credit. - a. The quantities to be credited under Items 9 and 10 will be the number of cubic yards placed as directed, measured in place after compacting. Credit shall include the work of preparing the base, spreading in layers, wetting, rolling or tamping, trimming to line, and shall include all labor and materials incidental to completing the embankment, not specifically included under other items. Credit will be made under Items 9 and 10 as applicable (see Paragraph 1-07).

b. To determine the quantities for which credit will be made, a survey will be conducted prior to the beginning of the placing of the fill. The true surface condition will be shown by cross sections and profile and the measurement of the quantities will be based upon this survey. The quantities will be the volume between the original surface at the beginning of the work, and the slope lines and grades as indicated on the drawings, as staked in the field or as directed by the District Engineer at the completion of the work.

c. Additional credit will be made to replace embankment washed out by flooding or scouring, or that required to be removed on account of slides, or the removal and disposal of all objectionable materials placed at the direction of the District Engineer; provided such replacement of embankment was not caused by negligence or carelessness of the Area Engineer. Quantities for additional credit will be measured as directed by the District Engineer, and credit will be made under the applicable item.

SECTION VI. MISCELLANEOUS FILL AND BACKFILL (Items 11 to 13 incl.)

6-01. General. - "Screened Gravel", Item 11, will be required for bedding under the hand-placed riprap as shown on the drawings and for filters. "Compacted Backfill", Item 12, is generally structure backfill at walls and structures as shown on the drawings. "Semi-compacted Backfill", Item 13, refers to miscellaneous backfill not completely compacted and required as shown on the drawings.

6-02. Screened gravel (Item 11). - a. Work included. - The Area Engineer shall place a layer of screened gravel or crushed stone for bedding upon which riprap will be placed at the locations shown on the drawings or as directed by the District Engineer. The Area Engineer shall also place a layer of screened gravel or crushed stone of the specified quality required for filters around drains at the locations shown on the drawings or as directed by the District Engineer.

b. Materials. - (1) Screened gravel shall consist of suitable coarse clean gravel satisfactorily graded within the specified limits. Unless otherwise directed, not more than 10 percent by weight shall pass a sieve having 10 meshes to the inch, and all shall pass a 2-inch square mesh screen. The material shall be obtained from sources approved by the District Engineer and shall be screened.

(2) Crushed stone shall consist of angular fragments of uniform quality throughout, free from soft or disintegrated stone, dirt or other objectionable matter. The provisions of Paragraph 8-07 b (2) shall apply, except that the 20 percent limitation on thin and elongated particles shall apply to the entire size range between the maximum and minimum limits specified. The stone shall be uniformly graded within the specified limits. Unless otherwise directed, not more than 10 percent by weight shall pass a No. 4 sieve, and all shall pass a 2-inch square mesh screen. The material shall be obtained from sources approved by the District Engineer and shall be screened.

c. Placing. - The material shall be placed as shown on the drawings or as directed, and with such hand placing as may be necessary to trim to the required slopes. The Area Engineer will not be required to tamp or roll the material, but will be required to consolidate it with water to the extent directed so that no settlement or voids will later result.

d. Measurement and credit. - The quantity to be credited under Item 11 will be the number of cubic yards furnished and placed to the limits shown on the drawings, or ordered. Credit will be made by the cubic yard under Item 11, "Screened Gravel".

6-03. Compacted backfill (Item 12). - a. Work included. - The Area Engineer shall place, grade and consolidate materials required for backfill at the flood wall and at other concrete structures, and elsewhere as shown on the drawings or as directed.

b. Materials. - Materials shall be borrowed from locations shown on the drawings, or may be obtained from required excavations. Backfill material shall be free from stumps, roots, sod, rubbish or other unsuitable materials or substances.

c. Placing. - The backfills shall consist of materials suitable for the purpose in the opinion of the District Engineer and shall be placed in successive layers of not more than 12 inches in depth for the full width of the cross section. Each layer shall be compacted thoroughly with a crawler type tractor weighing not less than 20,000 pounds. A minimum of four passes of the tractor treads on each square foot of backfill area will be required for satisfactory compaction. Portions of the backfill area which the compacting equipment cannot reach for any reason shall be spread in 4-inch layers and compacted thoroughly by tamping with hand or power tampers in 4-inch layers. The degree of compaction for such portions of the backfill shall be equivalent to that obtained by compacting with tractor equipment.

d. Measurement and credit. - Measurement will be made by the cubic yard for the amount of compacted backfill placed in the completed work to the lines and grades shown on the drawings or as directed by the District Engineer. Quantities will be measured in place after any settlement. Credit for all work in connection with furnishing and placing compacted backfill will be made by the cubic yard under Item 12, "Compacted Backfill".

6-04. Semi-compacted backfill (Item 13). - a. Work included. - The Area Engineer shall place, grade, and consolidate materials required for backfill of the concrete structures, and elsewhere as shown on the drawings or as directed.

b. Borrow. - Materials shall be obtained from stockpiles of excavated materials (see Paragraph 3-02 c), or may be obtained directly from required excavations. Backfill material shall be free from stumps, roots, sod, rubbish, or other unsuitable materials or substances.

c. Placing. - The backfills shall consist of materials suitable for the purpose as determined by the District Engineer, and shall be placed in successive layers of not more than 12 inches in depth for the full width of the cross section. Each layer shall be consolidated with water or otherwise compacted to the extent directed so that no settlement or voids will later result. The backfill adjacent to concrete structures shall be thoroughly compacted in 4-inch layers by tamping with hand or power tampers or otherwise as directed by the District Engineer.

d. Measurement and credit. - Measurement will be made by the cubic yard for the amount of semi-compacted backfill placed in the completed work to the lines and grades shown on the drawings or as directed by the District Engineer. Quantities will be measured in place after any settlement. Credit for all work in connection with furnishing and placing semi-compacted backfill will be made by the cubic yard under Item 13, "Semi-Compacted Backfill."

SECTION VII. RIPRAP AND DRAINS (Items 14 to 21 incl.)

7-01. General. - (1) Riprap construction will be required as shown on the drawings, as follows:

"Riprap - Hand Placed," Item 14, for the river-side slopes of dikes.
"Dumped Rock Fill," Item 15, for the river-side toe of the dike.
"Grouted Stone Gutters," Item 16, along ramps and elsewhere.

(2) Drains and accessories will be required as shown on the drawings, as follows:

"Manholes," Item 17.
"V. C. Tile Pipe," Items 18(a), 18(b) and 18(c).
"18-Inch V. C. Tile Pipe (Bituminous Joints)," Item 19.
"Flap Valves," Items 20(a) and 20(b).
"18-Inch Sluice Gate, Complete with Hoist and Accessories," Item 21.

7-02. Riprap - hand placed (Item 14). - a. Work included. - Hand-placed riprap shall be placed, to the lines and grades shown on the drawings, on the river-side slope of the dike and elsewhere as required by the District Engineer.

b. Materials. - Suitable rock obtained from removal of existing riprap may be used. Riprap shall be of durable rock of acceptable sizes with a minimum specific gravity of 2.65. Rock for riprap shall be angular and of uniform shape so as to furnish an even, reasonably smooth surface. Not more than 5 per cent by weight of the rock shall be smaller than one-half cubic foot in volume and at least 75 per cent of the rock used shall be from 1/2 to 1 cubic foot in volume with one dimension approximately equal to the depth of the riprap course.

c. Placing. - The riprap shall be laid to the lines and grades shown on the drawings or as directed. A tolerance of 3 inches above or below the slope line shown on the drawings will be allowed for the finished slope surface of the hand-placed riprap. The rock shall be closely laid on a base of screened gravel or crushed stone (See Paragraph 6-02), with the dimension approximately equal to the depth of the riprap, normal to the slope, and with joints broken where possible. The joints on the surface of the riprap shall be filled with tightly driven spalls. Large rock shall be well bedded at the edges of the riprap to prevent undermining.

d. Measurement and credit. - The quantity to be credited under Item 14 will be the number of cubic yards of riprap satisfactorily placed in the completed work to the specified or ordered lines and grades. Credit shall include all costs for furnishing, hauling and placing the riprap.

7-03. Dumped rock fill (Item 15). - a. Work included. - (1) The Area Engineer shall furnish all equipment and labor required to construct

the dumped rock fill along the river bank. The dumped rock fill shall be to the limits shown on the drawings or as directed by the District Engineer.

(2) The Area Engineer shall do all the preliminary grading and other incidental work, not included in any other item, required to prepare the site for the dumped rock fill.

b. Materials. - (1) Except as otherwise authorized by the District Engineer or shown on the drawings, dumped rock fill shall be composed of durable stone of acceptable sizes. Suitable rock, material obtained from the removal of existing riprap, boulders and large cobbles from borrow areas may be used. The dumped rock fill shall consist of fragments of stone of which none shall be smaller than one cubic foot and of which those exceeding one-half cubic yard shall constitute at least 50 per cent of the volume.

(2) Generally the maximum allowable size of single pieces of rock shall be one cubic yard.

c. Placing. - The dumped rock fill shall be constructed of the thickness and the extent shown on the drawings or directed. The average surface of the dumped rock fill shall satisfactorily approximate the required theoretical. Dumped rock fill need not be placed by hand, except to rearrange surface stones as necessary to fill unsatisfactory depressions in the surface below the required grades. The rock shall be carefully dumped in place with the larger rocks at the surface and the smaller rocks and spalls adjacent to the river bank. A tolerance of one foot above or below the slope line shown on the drawings will be allowed for the finished surface of the dumped rock fill.

d. Measurement and credit. - The quantity to be credited under Item 15 will be the number of cubic yards of rock fill satisfactorily placed in the completed work to the specified or ordered lines and grades. Credit will be made by the cubic yard under Item 15, "Dumped Rock Fill," and shall include the cost of all equipment, labor and incidentals required to construct and trim the dumped rock fill.

7-04. Grouted stone gutters (Item 16). - a. Work included. - (1) Hand-placed riprap shall be placed by the Area Engineer to the lines and grades shown on the drawings, for paving the gutters along the ramps at the locations shown on the drawings or elsewhere as directed by the District Engineer.

(2) The Area Engineer shall also furnish and place grout for surface grouting all hand-placed riprap in the gutters.

b. Materials and placing. - (1) Riprap shall be of durable rock of acceptable sizes. No individual rock shall be less than 10 pounds or more than 30 pounds in weight, and at least 75 per cent of the rock used shall be at least 20 pounds in weight. The riprap shall be laid to

the lines and grades shown on the drawings or as directed. The rock shall be hand-placed, to a tolerance of 1 inch above or below the finished surface shown on the drawings. The rock shall be closely laid on a base of screened gravel or crushed stone (see Paragraph 6-02), with the dimension approximately equal to the depth of the riprap normal to the slope, and with joints broken where possible.

(2) Grouting shall be done on clean riprap surface with grout mixture of 1 part Portland cement and 2-1/2 parts sand by volume combined with water to a suitable consistency. Cement and sand used in the grout shall conform to the provisions of Paragraphs 8-05 and 8-06. The grout shall be worked into the joints of the riprap surface with brooms or other means so as to fill the voids completely.

c. Measurement and credit. - The quantity to be credited under Item 16 will be the number of square yards of riprap placed to the specified lines and grades in the completed work. Credit shall include all costs for furnishing, hauling, placing and grouting the riprap.

7-05. Manholes (Item 17). - a. Work included. - The Area Engineer shall construct the manholes under Item 17 at the points indicated on the drawings, or as directed by the District Engineer.

b. Description. - (1) The manholes shall be built of brick masonry on concrete bases. They shall conform in shape, size, dimensions and in other respects to the details indicated on the drawings. Excavation for the manholes shall comply with the provisions of Paragraph 3-03, as far as they are applicable.

(2) The Area Engineer shall furnish all the materials required for the construction of the manholes, including brick, cement, sand, hydrated lime, waterproofing compound, concrete, cast iron manhole frames, covers and steps, and all other materials required. Concrete for manholes shall be Class "A" and shall comply with the provisions of Section VIII, as far as they are applicable.

c. Brick Masonry. - (1) Kind of brick. - The brick shall be good, sound, hard and uniformly burned brick, regular and uniform in shape and size, of compact texture and satisfactory to the District Engineer. Brick shall comply with Federal Specification SS-B-691, Grade B, standard size 2-1/4 by 3-3/4 by 8 inches. In case the District Engineer rejects any brick they shall be immediately removed from the work and brick satisfactory to the District Engineer substituted. Brick shall be culled and compactly piled as soon as delivered.

(2) Mortar for brickwork. - The mortar shall be composed of one part Portland cement and 2-1/2 parts sand, to which approximately 20 pounds of hydrated lime shall be added for each sack of cement. All mortar used shall be thoroughly mixed either by hand or in a mechanical batch mixer. Mortar shall be prepared in such quantities that it can be used entirely before it has attained its initial set. The minimum amount of water sufficient to make a workable mortar shall be used. Cement and sand used in mortar shall meet the requirements of Paragraphs 8-05 and 8-06. The hydrated lime shall be of approved commercial quality suitable for the use intended.

(3) Brick laying. - The bricks shall be clean and shall be thoroughly wetted shortly before they are put into the wall and each brick shall be laid in a full bed and joint of mortar, without requiring subsequent grouting, flushing or filling, and shall be thoroughly bonded as directed. Brickwork shall be satisfactorily protected against weather and frost until the mortar has set.

(4) Plastering. - Outside faces of brick masonry shall be plastered with Portland cement mortar. The thickness of the cement mortar plaster shall be from 1/4 inch to 3/8 inch and the mortar shall be carefully spread and thoroughly troweled, leaving a smooth exterior surface. The plaster shall be coated with 2 coats of bituminous-water-proof coating conforming to Federal Specification SS-A-666, Type III, brushed or sprayed on.

d. Iron castings. - (1) Quality of cast iron. - Cast iron manhole frames, covers and steps shall be as detailed on the drawings. The manhole cover and frame seats shall be the Construction Castings Corporation Type 173C-28090 or equal. The cast iron steps shall be Clow-National, catalog No. A-1483 or equal. Castings shall conform at least to the provisions of Federal Specification QQ-I-651.

(2) Painting castings. - Castings before being shipped from the foundry shall be given one coat of coal tar pitch varnish applied in a satisfactory manner so as to make a smooth coating, tough, tenacious and not brittle or with any tendency to scale off.

c. Credit. - Credit for Item 17, "Manholes", will be made on the basis of the brick manhole unit complete including cover and steps and shall include all costs for furnishing the materials, equipment and labor required to construct the brick manhole complete in accordance with the drawings and specifications, including shooting, shoring, excavation, concrete base, and backfilling.

7-06. Tile pipe, V. C. (Items 18(a) to 18(c) incl.) - a. Work included. - The Area Engineer shall furnish and lay V. C. tile pipes, including specials, of the required diameters for the drainage system. The Area Engineer shall connect the tile drains properly to existing sewers or other drains, as shown on the drawings. With reference to the toe drains at the land-side toe of the earth dike as shown on the drawings, only that portion of the drains shall be constructed as shall be specifically directed by the District Engineer to meet construction contingencies.

b. Materials. - All pipes shall be bell-and-spigot, (every third length perforated), vitrified, clay pipe conforming to the requirements of Federal Specification SS-P-361, or subsequent amendments or revisions thereof. Each pipe shall be carefully inspected immediately before laying and no cracked, broken or otherwise imperfect pipe shall be used, except for minor defects which in the opinion of the District Engineer do not impair the fitness of the pipe for the purpose intended.

c. Excavation. - Excavation shall be done as shown on the drawings and as provided for in Paragraph 3-03. Pipe trenches shall have a depth of not less than 2 feet and a width at least 12 inches greater than the outside diameter of the pipe. All rock or boulders shall be removed to a minimum depth of 6 inches below the bottom grade of the trench and the voids backfilled with well compacted suitable material.

d. Laying pipe. - All pipe shall be placed in the trench immediately after the excavation is completed, and the screened gravel or crushed stone filters are placed as shown on the drawings. Proper care shall be used in handling the pipe to avoid injury or breakage. The pipe shall be carefully bedded, and properly connected and jointed. Bell holes shall be excavated to insure that each pipe shall rest firmly upon its bed for the entire pipe length. The pipes shall be laid true to the lines and grades shown on the drawings or as staked in the field. Where shown on the drawings or specifically directed by the District Engineer, tile pipes in the toe drains shall be laid with every third length perforated, and with open joints with bells upgrade and with spigot ends fully entered in the bells. A strip of burlap, at least 6 inches in width and with a length 6 inches greater than the circumference of the pipe shall be carefully and securely wrapped around the pipe joints. Lateral drains as shown on the drawings shall be laid with mortar joints. The mortar for joints shall be composed of one part Portland cement and 2-1/2 parts sand. All mortar used shall be thoroughly mixed either by hand or in a mechanical batch mixer. Mortar shall be prepared in such quantities that it can be used entirely before it has attained its initial set. The minimum amount of water sufficient to make a workable mortar shall be used. Cement and sand used in mortar shall conform to the provisions of Paragraphs 8-05 and 8-06. The spigots shall be centered in the bells and there shall be no shoulders or unevenness of any kind along the bottom half of the pipes. Special care shall be taken that the joint space be of equal width around the pipe, making use of jute or oakum gaskets, soaked in cement grout to center the pipe. The mortar shall be troweled into the joint and a sufficient backfill shall be made to hold the mortar in the joint firmly in place. The interior of the pipe shall be carefully cleaned after laying to remove dirt, mortar and other obstructions.

e. Backfilling. - Backfill material as shown on the drawings shall be evenly spread and compacted around and over the pipe to the limits shown on the drawings or as directed by the District Engineer. (See Paragraph 6-02.) Hand tamping shall be done as directed. Tar paper shall be furnished and placed as shown on the drawings, to prevent filtering of fine material into the drain.

f. Measurement and credit. - (1) Measurement for credit will be based on the linear foot of pipe of the size installed. Credit will be made by the linear foot under Items 18(a), 18(b), and 18(c), as applicable, "V. C. Tile Drains." Credit shall include all costs of furnishing and installing the pipe including specials, except the cost of excavation and backfilling.

(2) Credit for excavation will be made under Item 4 (see Paragraph 3-03). Credit for backfilling will be made under Item 11 (see Paragraph 6-02).

7-07. 18-Inch V.C. tile pipe (bituminous joints) (Item 19). - a. Work included. - The Area Engineer shall furnish and lay with bituminous joints, tile pipes, including specials, of the required diameters for the

acid drain at the locations shown on the drawings. The Area Engineer shall connect the tile drains to the manhole or other drains as shown on the drawings.

b. Materials. - (1) All tile pipes shall be bell-and-spigot, vitrified, clay pipe conforming to the requirements of Federal Specification SS-F-361, or subsequent amendments or revisions thereof. Each pipe shall be carefully inspected immediately before laying and no cracked, broken or otherwise imperfect pipe shall be used, except for minor defects which in the opinion of the District Engineer do not impair the fitness of the pipe for the purpose intended.

(2) Bituminous joint material shall be Puroseal as manufactured by The Puroseal Company of Newark, N. J., or approved equal.

(3) Asphalt paint shall conform to the requirements of Federal Specification TT-V-51, Grade B.

c. Excavation. - Excavation shall be done as shown on the drawings and as provided for in Paragraph 3-03. Pipe trenches shall have the dimensions shown on the drawings and shall provide for the concrete encasement. Where encountered, rock or boulders shall be removed to a depth of 6 inches below the bottom grade of the trench and the voids back-filled with well compacted suitable material unless otherwise shown on the drawings.

d. Placing. - (1) Where the drawings show the pipe encased in concrete, the concrete base shall be placed to sufficient height to form a secure support for the entire pipe length. The pipe shall be painted on the outside with an approved asphalt paint, (see Paragraph 7-07 b (3)), and shall be carefully bedded and properly connected and jointed before placing the remainder of the concrete encasement.

(2) Where the drawings do not show the pipe encased in concrete, bell holes shall be excavated to insure that each pipe shall rest firmly upon its bed for the entire pipe length, the pipe shall be carefully bedded and properly connected and jointed.

(3) The pipe shall be laid true to the lines and grades shown on the drawings or as staked in the field. The pipe shall be laid with bituminous joints. The joints shall be caulked with a ring of dry jute, oakum or hemp of approved quality, to a depth equal to one quarter of the depth of the bell and filled with an approved asphalt composition heated to about 350 degrees and poured in place with the aid of pipe jointer, clamps, and asbestos runner.

e. Backfilling. - Backfill materials shall be evenly spread and compacted around and over the pipe to the limits shown on the drawings or as directed by the District Engineer. Hand tamping shall be done as directed. Concrete for encasement of tile pipe shall be Class "A" concrete conforming to all requirements of Section VIII.

f. Measurement and credit. - (1) Measurement for credit will be based on the linear feet of pipe installed. Credit will be made by the linear foot under Item 19, "18-Inch V.C. Tile Pipe (Bituminous Joint)." Credit shall include all costs of furnishing and installing pipe including specials, except the cost of excavation, concrete and backfilling.

(2) Credit for excavation will be made under Item 4 (see Paragraph 3-05). Credit for concreting or backfilling will be made under Items 24 and 13 (see Paragraphs 9-05 b and 6-04 d), as applicable.

7-08. Flap valves (Items 20(a) and 20(b)). - a. Work included. - The Area Engineer shall furnish and place the flap valves as shown on the drawings.

b. Materials. - The flap valves shall be of cast iron body bronze mounted or other approved corrosion resisting material, suitable for use under 10 to 20-foot head as shown on the drawings, flanged, drilled and faced, similar and equal to the Chapman Flap valve, and shall conform to the requirements of current American Water Works Association specifications applicable to the size and use intended.

c. Credit. - Credit for the flap valve units will be made under Items 20(a), "10-Inch Flap Valve," and 20(b), "18-Inch Flap Valve," as applicable, and shall include all costs of furnishing and installing the valves.

7-09. Sluice gate, complete with hoist and accessories (Item 21). -

a. Work included. - The Area Engineer shall furnish and install a hand-operated sluice gate, as shown on the drawings, complete with hoist and accessories, all in accordance with the drawings and the specifications.

b. Description. - The gate shall be Chapman, Table 6 Type, or equal and shall be of cast iron with bronze seals, or other approved corrosion resisting materials and shall be designed to operate satisfactorily under all heads up to and including the maximum hydrostatic head of 25 feet at the center of the gate opening. The dimensions of the gate opening shall be 18 by 18 inches, with the gate fully raised. The gate shall be hand-operated by means of rising-stem hoist actuated by hand wheel. The gate shall seat or unseat satisfactorily under the maximum hydrostatic head with not more than a 40-pound pull on the hoist wheel. When seated the gate shall be practically water-tight.

c. Gate details. - (1) The gate shall consist of a rectangular cast iron plate (or leaf) with horizontal and vertical ribs. Bronze seat facings shall be driven into dovetail grooves machined in the face of the gates.

(2) The gate shall have a rising stem of sufficient size to withstand safely, without buckling, the whole thrust due to closing the gate under the maximum operating head. The gate stem shall be cold-rolled steel in sections not exceeding 12 feet in length. The sections

of each stem shall be jointed together by solid manganese-bronze couplings threaded and keyed to the stems.

(3) The stem shall be furnished with stem guides so that the unsupported length of stem shall not exceed 12 feet. All stem guides shall be bronze-bushed and adjustable.

d. Frame and guides. - (1) The gate frame shall be of the standard flat type having the rear face machined and drilled to attach to concrete and the front face machined to take the sluice gate guides. The frame shall be of cast iron of ample section to prevent distortion and shall be cast in one piece. Bronze seat facings shall be driven in to dovetail grooves machined in the front face of the frame.

(2) The guides shall be of cast iron of sufficient length so that not less than one-half of the gate is within the guides when the gate is fully open.

e. Hoist. - (1) The gate hoist shall be Chapman, Table 118, Type "BR" or equal, one-speed unit designed and built for hand operation of sluice gates, and shall be of sufficient capacity to raise or lower the gate against the maximum operating head with not more than a 40-pound pull on the hand wheel.

(2) The pedestal and gear cases shall be made of cast iron conforming to Federal Specifications QQ-I-651. The operating nut shall be of cast bronze. The shaft shall be provided with plain bushings.

f. Furnishings and fittings. - (1) The gate frame, guides and hoist shall be designed and constructed to provide a satisfactory method of fastening them securely to concrete or other supports during erection as shown on the drawings. All bolts, special tools and other devices necessary to erect the gate, frame, guides and hoist as shown on the drawings shall be furnished by the manufacturer.

(2) All bolts, nuts, screws, studs, pins, etc., shall be securely locked by satisfactory devices that will prevent loosening due to vibration.

g. Installation. - The gate shall be completely assembled during installation and the leaf shall be screwed lightly into its seat and shall be held in place by jack screws. Care shall be exercised when drawing the frame up to the concrete to insure its being pulled against a true surface. All bolts shall be tightened carefully so as not to strain or warp the parts and to preserve proper alignment. Grout shall be poured between the face of the flange and the concrete to prevent any tendency to spring the frame. After installation the jack screws shall be removed and discarded.

h. Inspection and tests. - (1) The gate, hoist and accessories to be furnished shall be assembled in the shop as directed by the

District Engineer for inspection and to insure that all parts fit accurately and are in proper alignment. Each gate shall be opened and closed to insure proper operation.

(2) After completion of the installation, the gate shall be tested for satisfactory operation by being raised and lowered several times for its full length of travel. Any adjustments in the setting or installation required to secure satisfactory operation and tight closure of the gate shall be made by the Area Engineer. The gate hoist shall be tested as directed and any adjustments or changes that may be required in the opinion of the District Engineer shall be done by the Area Engineer.

(3) The cost of all testing shall be borne by the manufacturer, except for the Government's representatives, and shall be included in the credit for Item 21.

1. Painting. - (1) Preparation of surface. - All unfinished iron and steel surfaces shall be prepared for painting by thoroughly cleaning the metal surfaces and removing all mill scale, dirt, grease, rust, and other foreign substances.

(2) Materials. - All paint materials shall conform to Federal Specifications for Group "TT", where they are applicable.

(3) For gate and gate guides there shall be one coat of metal filler, one shop coat of red lead paint and one field coat of red lead paint orange in color and two finish coats of graphite paint. Painting shall be similar or equal to Detroit Graphite Company's Iron-Gard System for underwater steel structures.

(4) For gate hoist there shall be applied one coat of metal filler, one shop coat of red lead paint, one field touch-up coat of red lead paint, and two coats of selected engine enamel.

(5) The touch-up coat shall be applied as may appear necessary to the District Engineer and shall be done with the same shade as the shop coat.

j. Credit. - Credit for furnishing, painting and installing the work included in Paragraph 7-09 a will be made under Item 21, "Sluice Gate, Complete with Hoist and Accessories."

SECTION VIII. CONCRETE (Items 22 to 25 incl.)

COMPOSITION, CLASSIFICATION AND STRENGTH

8-01. Composition. - Concrete shall be composed of cement, fine aggregate, coarse aggregate and water so proportioned and mixed as to produce a plastic, workable mixture in accordance with all requirements under this section and suitable to the specific conditions of placement.

8-02. Classification. - Except where required to meet special conditions all concrete shall be Class "A", as designated in Section IX and on the drawings for the various parts of the work in accordance with the conditions of application and the proportions of materials and strengths required.

8-03. Strength. - The mixes shall be designed to secure concrete having at least the following compressive strengths at the age of 28 days, as determined by breaking standard 6-inch diameter by 12-inch height or 8-inch diameter by 16-inch height test specimens:

Class	Average for any 25 consecutive cylinders	Minimum for any one cylinder
A	3400 lbs. per sq. in.	2600 lbs. per sq. in.

8-04. High-early-strength concrete. - High-early-strength concrete made with high-early-strength Portland cement or other special cements shall be used only when specifically authorized by the District Engineer. The 7-day compressive strength of concrete of any class, when made with high-early-strength cement, shall be at least equal to the specified minimum 28-day compressive strength for that class. All provisions of these specifications, except for cement, shall be applicable to such concrete. Any high-early-strength cement used shall be subject to approval by the District Engineer before use.

MATERIALS.

8-05. Portland cement (Item 22). - a. The Area Engineer shall furnish Portland cement of the quality herein specified in sufficient quantity for the work required. Cement for all concrete, grout and mortar, except as specified in subparagraph b, shall conform to Federal Specification SS-C-206, for "Cement, Portland, Moderate-Heat-of-Hardening, September 30, 1936," except that Paragraph E-7, "Heat of Hydration," shall be considered inoperative.

b. High-early-strength Portland cement. - Cement for high-early-strength concrete shall be in accordance with Federal Specifications SS-C-201, for "Cement, Portland, High-Early-Strength."

c. Special test requirements. - Cement will be tested by the Government at the Central Concrete Laboratory, West Point, New York. No cement shall be used until notice has been given by the District Engineer that the test results are satisfactory. Cement which has been stored, other than in the bins at the mills, for more than 4 months after being tested shall be retested before use. Ordinarily, no cement shall be used until after it has satisfactorily passed both the 7 and 28-day tests, but in cases of emergency the District Engineer may waive the 28-day tests and permit the use of cement which has satisfactorily passed the soundness and 7-day tests; provided it is the product of a quarry and mill having established a reputation of not less than 3 years' standing, for the production of high-grade cement. If the tests prove any cement unsatisfactory which has been delivered at the site of the work, such cement shall be promptly removed from the work and its vicinity.

d. Identification. - Cement shipped in bags shall be identified by marking or tagging the bags with the identifying number or symbol of the Federal Specification under which it was manufactured. Bulk shipments of cement shall be likewise identified by a suitable device affixed to each car or other type of bulk carrier. Marking or tagging shall be done at the mill.

e. Quality and packages. - All cement shall be dry, finely ground and free from lumps or caking. Unless otherwise permitted, the cement shall be delivered in canvas bags or other strong, well-made packages, each plainly marked with the manufacturer's brand. The weights of such bags shall be uniform. Packages received in broken or damaged condition shall be rejected or accepted only as fractional packages. Cement shall be stored in a satisfactory manner so as to be unaffected by moisture.

f. Records of cement used. - The Area Engineer shall furnish to the District Engineer at the end of each day's work, a statement showing in such detail as he may reasonably require the quantity of cement used during the day at each part of the work.

118-06. Fine aggregate. - a. Composition. - Fine aggregate shall be natural sand.

b. Quality. - Fine aggregate shall consist of hard, strong, durable and uncoated particles.

c. Grading. - (1) Except as provided in (2) below, fine aggregate shall conform to the following requirements:

Total passing -	Per cent by weight
No. 4 sieve	95 - 100
No. 16 sieve	45 - 75
No. 50 sieve	10 - 25
No. 100 sieve	1.5 to 7

(2) Deficiencies in the percentages of fine aggregate passing the #50 and #100 sieves, as required in the above gradation, may be remedied by the addition of pozzuolanic or cementitious materials, excepting Portland cement; provided, at least 5 per cent passes the #50 sieve and the aggregate is of proper consistent gradation within the specified limits. Such added material, which will be considered and included as fine aggregate, shall conform to the requirements in Paragraph 8-08 and shall be in sufficient quantity to meet the minimum requirements above for percentage passing the #100 sieve and otherwise to produce the workability required by the District Engineer. The quantity and characteristics of any material used for the purpose of correcting workability shall be such that when the concrete is gaged to the proper consistency the total water content shall not exceed by more than 1 gallon per cubic yard the minimum quantity required for proper consistency when not using the admixture. The blending of any material with the original naturally graded sand to remedy deficiency in gradation shall be accomplished in charging the mixer, unless otherwise specifically authorized by the District Engineer.

d. Deleterious substances. - The substances designated shall not be present in excess of the following amounts:

	Per cent by weight
Clay lumps	
Material removed by decantation from aggregates not more than	3
Shale	0.5

e. Mortar strength. - Mortar specimens made with the fine aggregate shall have a compressive strength at 28 days of at least 90 per cent of the strength of similar specimens made with Ottawa sand having a fineness modulus of 2.40 \pm 0.10 and the same cement.

f. Tests. - Fine aggregate shall be subject to careful, thorough analyses, including magnesium sulphate soundness tests (see Paragraph 8-07d), to determine conformity with all requirements of these specifications.

8-07. Coarse aggregate. - a. Composition. - Coarse aggregate shall be washed gravel, crushed stone, or any approved mixture of washed gravel and crushed stone.

b. Quality. - (1) Coarse aggregate shall consist of hard, tough, and durable particles free from adherent coating. It shall contain no vegetable matter nor soft, friable, thin or elongated particles in quantities considered deleterious by the District Engineer (see subparagraph (2) below). The substances designated shall not be present in excess of the following amounts (by weight):

Soft fragments	5%
Clay lumps	1 1/4%
Removed by decantation	1

When the material removed by decantation consists essentially of crusher dirt the maximum amount permitted may be raised to 1-1/2 per cent. When crushed stone is used, the crusher shall be equipped with a screening system which will entirely separate the dust from the stone and convey it to a separate bin.

(2) Aggregate which has disintegrated or weathered badly under exposure conditions similar to those which will be encountered by the work under consideration, shall not be used. Aggregate shall not be used which contains more than 20 per cent by weight of thin and elongated particles as defined below:

Thin particles - those whose average thickness (minimum diameter) is less than 1/4 their length (maximum diameter).

Elongated particles - Those whose average width (secondary diameter) is less than 1/2 their length (maximum diameter).

The 20 per cent limitation on thin and elongated particles shall apply to each of three size ranges, 3/4 to 1 1/2-inch, 1 1/2-inch to 1-inch, 1-inch to 2-inch (see Paragraph 8-07 d (2)).

c. Size. - (1) Coarse aggregate shall be well graded from fine to coarse so that concrete of the required workability, density, and strength can be made without the use of an excess amount of sand, water, or cement.

For Class "A" concrete, the maximum size mesh screen for the aggregate shall be 1 inch.

Within the above-indicated size limits, not less than 85 per cent of the material shall be retained on a standard square mesh screen of the minimum size indicated and not more than 5 per cent shall be retained on a standard square mesh screen of the maximum size indicated.

(2) The grading of the coarse aggregate, in the mixed concrete, shall fall within the following limits:

(Per cent by weight)

	Passing	
Maximum size mesh screen (square mesh)	97	- 100
1/2 maximum size mesh screen (square mesh)	40	- 70
No. 4 sieve	0	- 6

d. Tests. - (1) Coarse aggregate will be subjected to freezing and thawing tests and to careful, thorough analyses to determine conformity with all requirements of these specifications. Coarse aggregate will be subjected to 10 cycles of the magnesium sulphate test for soundness. No aggregate shall be used which develops a loss in excess of 10 per cent by weight.

(2) The determination of thin and elongated particles will be made by counting rejects from representative samples (see Paragraph 8-11). The size of sample shall be not less than:

- 5 pounds, for the $\frac{3}{4}$ to $\frac{1}{2}$ -inch size range
- 10 pounds, for the $\frac{1}{2}$ -inch to 1-inch size range
- 20 pounds, for the 1-inch to 2-inch size range

Of those particles which appear in a border-line classification,-- neither unquestionably suitable for use nor unquestionably unsuitable,-- one-half shall be counted as rejects and one-half as suitable for use. The percentage of total rejects from each sample shall be determined.

8-08 Material added for workability. - a. The use of any material added to the mix to improve workability (see Paragraph 8-06 c (2)), which, in the opinion of the District Engineer, may have an injurious effect on the strength, density, and durability of the concrete, will not be permitted. Before approval of any material, the Area Engineer will be required to submit the results of complete chemical and sieve analyses made by an acceptable testing laboratory. Subsequent tests will be made of samples taken by the District Engineer from the supply of the material being used on the work to determine whether it is uniform in quality with that approved.

b. The material added shall be pozzuolanic, cementitious or silicious. It shall not contain effective early-heat-producing elements, or compounds, such as those contained in Portland cement, nor shall its use result in a material increase in the free-lime content of the concrete. It shall also be in conformity with the following requirements:

- Free moisture - a total of not more than 3 per cent by weight.
- Passing #30 sieve - not less than 100 per cent by weight.
- Passing #200 sieve - not less than 85 per cent by weight.

8-09. Water. - The water used in mixing concrete shall be fresh, clean and free from injurious amounts of oil, acid, alkali, or organic matter.

8-10. Storage. - a. Cement. - Immediately upon receipt, at the site of the work, cement shall be stored in a thoroughly dry, weather-tight, and properly ventilated building with adequate provisions for the prevention of the absorption of moisture. The building shall be of adequate capacity to provide for the requirements of delivery and construction schedules. Storage shall be such as to permit easy access for inspection and definite identification of each shipment.

b. Aggregates. - The fine and coarse aggregates shall be stored separately and in such manner as to avoid the inclusion of any foreign material in the concrete. Stock-piles of coarse aggregates shall be built in horizontal layers to avoid segregation.

8-11. Sampling and testing aggregates. - Except where provided otherwise by these specifications, all sampling and testing of aggregates shall be made in accordance with the Federal Specifications. Unless specified otherwise, all test samples shall be taken under the supervision of the District Engineer and supplied to the Central Concrete Laboratory, West Point, New York, by the dealer at his expense. The source from which concrete aggregates are to be obtained shall be selected by the Area Engineer well in advance of the time when they will be required in the work, and suitable samples as they are to be used in the concrete shall be furnished to the District Engineer at least 30 days in advance of the time when the placing of the concrete is expected to begin. The Area Engineer shall obtain fine and coarse aggregates for concrete from sources approved by the District Engineer.

PROPORTIONING, MIXING AND PLACING.

8-12. Proportioning. - a. Basis. - All concrete materials will be proportioned so as to produce a workable mixture in which the water content will not exceed the maximum specified.

b. Control. - The exact proportions of all materials entering into the concrete shall be as directed by the District Engineer. The Area Engineer shall provide all equipment necessary to positively determine and control the actual amounts of all materials entering into the concrete. The proportions will be changed whenever in the opinion of the District Engineer such change becomes necessary to obtain the specified strength and the desired density, uniformity and workability, and the work will not receive additional credit because of such changes.

c. Measurement. - All materials shall be measured by weight except that water may be measured by volume when so authorized by the District Engineer. One bag of cement will be considered as 94 pounds in weight and 1 gallon of water as 8.33 pounds.

d. Cement content. - Each cubic yard of concrete shall contain not less than the quantity of cement stated below:

Class "A" - 5.0 bags or 470 pounds

For concrete deposited in water the minimum cement content shall be 6.5 bags or 611 pounds to each cubic yard of concrete in place.

e. Water content. - (1) In calculating the total water content in any mix the amount of moisture carried on the surface of the aggregate particles shall be included. The total water content

for a bag of cement for each batch of concrete shall not exceed the following:

Class "A" - 6.0 gallons or 50.0 pounds

In all cases, however, the amount of water to be used shall be the minimum amount necessary to produce a plastic mixture of the strength specified and of the desired density, uniformity and workability. In general, the consistency of any mix shall be that required for the specific placing conditions and methods of placement, and ordinarily the slump shall be between 1 inch and 3 inches when tested in accordance with the current specifications for "Method of Test for Consistency of Portland Cement Concrete," of the American Society for Testing Materials.

(2) An increase in the maximum water content, based only on the requirements of materials added in accordance with Paragraph 8-06 c (2) to improve workability will not be permitted unless comparative tests under job conditions show conclusively that such increase in water content will not result in a decrease in concrete strength and provided further that such increase does not exceed 1 gallon per cubic yard.

f. Aggregate content. - The total volume of aggregates to be used in each cubic yard of concrete shall be that necessary to produce a dense mixture of the required workability as determined by the District Engineer.

8-13. Mixing and placing. - a. Equipment at the site. - (1) The Area Engineer shall provide at the site of the work an approved power driven mixer in good condition of adequate size for the work, or the District Engineer may approve the use of truck mixed concrete from a commercial source. Adequate equipment and facilities shall be provided for accurate measurement and control of all materials and for readily changing the proportions of materials to conform to the varying conditions of the work, in order to produce concrete of the required uniform strength and workability.

(2) Time. - The minimum time for mixing each batch, after all materials are in the mixer, shall be as follows:

1/2 cu. yd. mixer, or smaller	1-1/4 minutes
3/4 to 1-1/2 cu. yd. mixer	1-1/2 minutes

The mixer shall revolve a minimum of 12 revolutions after all materials have been placed in it, and at a uniform speed. Neither speed nor volume capacity of the mixer shall exceed those recommended by the manufacturer. Excessive overmixing, requiring additions of water to preserve the required consistency, will not be permitted.

b. Truck mixing. - (1) When truck mixed concrete is approved by the District Engineer the proportioning plant shall conform to the following requirements:

The complete plant assembly, including provisions to facilitate the inspection of all operations at all times with suitable quarters within which to prepare reports, and the adequacy and dependability of each of its parts, shall be subject to the approval of the District Engineer.

The equipment shall provide adequate facilities for the accurate measurement and control of each of the materials entering the concrete.

It shall be capable of ready adjustment for compensating for the varying moisture content of the aggregates and for changing the proportionate batch weights.

It shall be capable of controlling the delivery of all materials to within one per cent by weight of the specified amounts.

It shall be arranged to permit the convenient removal of materials in excess of the specified tolerances.

It shall include a visible dial or equally suitable device which will accurately register the scale load.

The accuracy of the weighing equipment shall conform to the requirements of the U. S. Bureau of Standards and shall be tested monthly, without expense to the Government.

(2) The size of the batch shall not exceed the maximum rated capacity of the mixer as stated by the manufacturer and as stamped in metal in a prominent place on the mixer. The mixer shall be water-tight when closed. Each batch of concrete shall be mixed not less than 50 nor more than 150 revolutions of the mixer at the rate of rotation specified by the manufacturer as mixing speed. Additional mixing, if any, shall be done at a slower speed specified by the manufacturer for agitation. Except as subsequently provided, the truck mixer shall be equipped with a tank for carrying the mixer water. The water shall be measured and placed in the tank at the proportioning plant unless the tank is equipped with an automatic measuring device of the required accuracy and capable of being locked. The truck shall be equipped with a discharge chute and extension.

(3) Delivery. - Concrete shall be hauled in a water-tight container in which segregation will not take place, and from which concrete can be discharged freely, and shall be delivered to the work at the consistency specified.

(4) Time of hauling. - Concrete shall be delivered to the site of the work, and discharge from the hauling container shall be completed within a period of 45 minutes after the introduction of the mixing water to the cement and aggregates, or the cement to the aggregate when the fine aggregate contains moisture in excess of 6 per cent by weight and the coarse aggregate contains moisture in excess of 3 per cent by weight.

(5) Temperature. - Concrete delivered in outdoor temperatures lower than 40 degrees F. (5 degrees C.) shall arrive at the work having a temperature not less than 60 degrees F. (15 degrees C.), nor more than 100 degrees F. (38 degrees C.).

c. Conveying. - Concrete shall be conveyed from mixer to forms as rapidly as practicable, by methods which will prevent segregation or loss of ingredients. It shall be deposited as nearly as practicable in its final position. Conveying of concrete by means of chutes will not be permitted except for short chutes in the forms to distribute the concrete. Chutes used shall be such that the concrete slides in them and does not flow. Chutes with a flatter slope than 1 on 2 will not be permitted. There shall be no free vertical drop greater than 5 feet except where specifically authorized by the District Engineer.

d. Placing. - (1) Concrete shall be placed before initial set has occurred, and in no event after it has contained its water content for more than 45 minutes.

(2) Unless otherwise specified, all concrete shall be placed in the dry upon clean, damp surfaces, free from ice, frost or running water, and never upon soft mud, dry porous earth, or upon fills that have not been subjected to approved rolling, puddling or tamping so that ultimate settlement has occurred.

(3) Rock surfaces upon which concrete is placed shall be approximately horizontal or stepped, rough, and free from loose material or other matter interfering with a satisfactory bond. The rock shall be washed, scrubbed with steel brushes or brooms, and spread with a layer of mortar about 1/2 inch thick, immediately before the concrete is placed. The mortar shall be of the same cement-sand ratio as used in the concrete.

(4) Unless otherwise specifically authorized or directed, concrete in mass structures shall be placed in monoliths not exceeding 40 feet in length or width. The layout of all monoliths shall be as directed or approved by the District Engineer before concreting is commenced.

(5) All concrete shall be deposited in approximately horizontal layers not to exceed 24 inches in thickness unless otherwise specifically authorized or directed by the District Engineer and

the concreting shall be carried on as a continuous operation, as far as practicable, until the placing in the course, section, panel or monolith is completed. Courses shall generally have a minimum thickness of 4 feet, and a maximum of 18 feet, except that in hot weather the District Engineer may direct that the maximum be reduced to 8 feet. A minimum time interval of 48 hours shall be allowed between successive courses for the dissipation of heat of hydration.

(6) Concrete shall be placed with the aid of mechanical vibrating equipment as approved by the District Engineer. Vibration shall be transmitted directly to the concrete, and in no case shall it be transmitted through the forms. The frequency of vibration shall be not less than 5000 per minute. The intensity of vibration shall be sufficient to cause flow or settlement of the concrete into place. The vibration shall be of sufficient duration to accomplish thorough compaction as approved by the District Engineer. Vibration shall be supplemented by forking or spading by hand adjacent to the forms on exposed faces in order to secure smooth, dense, even surfaces. The concrete shall be compacted and worked in an approved manner into all corners and angles of the forms and around reinforcement and embedded fixtures.

(7) In dropping concrete through reinforcement, care shall be taken that no segregation of the coarse aggregate occurs. On flat surfaces, where the congestion of steel near the forms makes placing difficult, a mortar of the same cement-sand ratio as is used in the concrete shall be first deposited to cover the forms.

(8) All top surfaces not covered by forms and which are not to be covered by additional concrete or backfill shall be carried slightly above grade and struck off by board screed (see Paragraph 8-15).

e. Construction joints. - Vertical joints shall be formed with tongue-and-groove bonds or keys at such locations and of such shapes and dimensions as approved or directed by the District Engineer. Horizontal joints shall be formed as shown on the drawings, or, where horizontal pressure is always in one direction, with steps. Where required, dowel rods shall be used. All concrete in vertical members shall have been in place not less than 12 hours, and longer if so directed by the District Engineer, before concrete in horizontal members resting thereon is placed. As soon as practicable after placing and immediately before placing the succeeding layers is resumed, all approximately horizontal surfaces shall be washed with a high pressure air-and-water jet, or cleaned as otherwise directed by the District Engineer. Sand shall be added to the air-and-water jet when required, to remove alkali, algae, stains, and other substances injurious to the bond. The time and method of using the jet shall be such that all laitance, scum, etc. will be removed so that partly embedded aggregate is not disturbed and is washed clean. After final cleaning and immediately before placing is resumed, the surfaces shall be wetted and spread with a layer of mortar 1/2 inch thick, thoroughly

brushed in. The mortar shall be the same cement-sand ratio as the concrete. Where specified or otherwise required by the District Engineer for watertight construction, copper strips not less than 18 inches in width and weighing not less than 20 ounces per square foot, properly crimped or bent, shall be placed in the concrete to span the joint.

f. Cold weather. - Concrete shall not be placed when the ambient atmospheric temperature is below 35 degrees F., nor when the concrete is likely to be subject to freezing temperatures before final set has occurred, unless specifically authorized by the District Engineer in writing. When so authorized, the materials shall be heated in order that the temperature of the concrete, when deposited, shall be not less than 50 degrees F. nor more than 70 degrees F. All methods and equipment for heating shall be subject to the approval of the District Engineer.

g. Hot weather. - For concrete placed during the extremely warm summer months and otherwise, when directed by the District Engineer, the aggregates shall be cooled by frequent spraying in such manner as to utilize the cooling effect of evaporation. During such periods the placement schedule shall be arranged as approved by the District Engineer in such manner as to provide time for the temperature of the previously placed course to begin to recede. The mixing water shall be the coolest available at the site in so far as is practicable.

8-14. Test specimens. - a. Number. - Test specimens, to determine whether the compressive strength of the concrete is in accordance with that specified in Paragraph 8-03, will be taken by the inspector. At least 1 set of 3 specimens will be made for every major pour and in general for every 100 cubic yards of concrete placed, but in any event, a sufficient number of specimens will be taken to give a comprehensive knowledge of the concrete in each section of the work.

b. Method. - All specimens will be taken from the concrete at the mixing plant unless otherwise directed by the District Engineer. The specimens will be tested by the Government at the Central Concrete Laboratory, West Point, New York. All costs of transportation and testing of specimens will be borne by the Government.

8-15. Finishing. - Immediately after placement, the concrete shall be properly forked back along the faces of all forms by the use of standard concrete forks or spades unless otherwise specifically authorized or directed by the District Engineer. The finished surfaces shall be free from sand streaks or other voids and the plastering over of such surfaces will not be permitted. Defective concrete shall be repaired by cutting out the unsatisfactory material, in no case less than 2 inches deep, and placing new concrete which shall be formed with keys, dovetails or anchors to attach it securely to the other work. One anchor shall be placed for each 64 square inches of area and the sides of the cut areas shall be generally rectangular. This concrete shall be drier than the usual mixture and shall be thoroughly tamped into place behind forms securely fastened. Unless otherwise specified, all surfaces of

concrete, not covered by forms, that are not to be covered by additional concrete, or backfill, shall have a wood float finish without additional mortar, and shall be true to elevations as shown on the drawings. Care shall be taken to see that all excess water is removed before making this finish. Other surfaces shall be brought to the specified finished elevation and left true and regular as approved by the District Engineer. Where considered necessary by the District Engineer, or where indicated on the drawings, joints shall be carefully made with a jointing tool. Every precaution shall be taken by the Area Engineer to protect finished surfaces from stains or abrasions. No fire shall be permitted in direct contact with any concrete at any time. Concrete surfaces, or edges likely to be injured during the construction period, shall be properly protected by leaving the forms in place, or by erecting covers satisfactory to the District Engineer.

8-16. Curing. - a. Warm weather. - All concrete shall be adequately protected from injurious action by the sun. Fresh concrete shall be protected from heavy rains, flooding water, and mechanical injury. All concrete shall be kept wet for a period of not less than 14 days by covering with water, or with an approved water-saturated covering, or by a system of perforated pipes, or mechanical sprinklers, or any other approved method which will keep all surfaces continuously (not periodically) wet. Where wood forms are left in place for curing, they shall be kept wet at all times to prevent opening at the joints and drying out of the concrete. Water for curing shall be generally clean and entirely free from any elements which in the opinion of the District Engineer might cause staining or discoloration of the concrete.

b. Cold weather. - Concrete when placed during cold weather shall be kept moist and provided with adequate protection for a period of not less than 14 days, subject to the approval of the District Engineer, so that the air in contact with the concrete will be maintained at temperatures between 50 degrees F. and 70 degrees F. for at least the first 5 days of the curing period. For massive sections, where the atmospheric temperatures are sufficiently low in the opinion of the District Engineer to cause excessively rapid cooling and contraction of the exterior surfaces, this period for maintaining the temperature of the air in contact with the concrete between 50 and 70 degrees F. shall extend over the entire curing period. Salt or other chemicals shall not be admitted into the mixture to prevent freezing except with the approval of the District Engineer.

FORMS, REINFORCEMENT AND CREDIT.

8-17. Forms. - a. Materials. - Forms shall be of wood, steel or other approved material, except that where lining is not specified, the sheeting for all exposed surfaces shall be tongue-and-groove lumber of uniform width unless otherwise specifically authorized. Forms of like character shall be used for similarly exposed surfaces in order

to produce a uniform appearance. The type, size, shape, quality and strength of all materials of which the forms are made shall be subject to the approval of the District Engineer.

b. Construction. - Forms shall be built true to line and grade, and shall be mortar-tight and sufficiently rigid to prevent displacement or sagging between supports. Responsibility for their adequacy shall rest with the Area Engineer. Their surfaces shall be smooth and free from irregularities, dents, sags, or holes when used for permanently exposed faces. Bolts and rods used for internal ties shall be so arranged that, when the forms are removed, all metal will be not less than 2 inches from any concrete surfaces. Wire ties will not be permitted where the concrete surface will be exposed to weathering and discoloration will be objectionable. All forms shall be so constructed that they can be removed without hammering or prying against the concrete. Unless otherwise indicated, suitable moldings shall be placed to bevel or round exposed edges, at expansion joints or any other points as may be required by the District Engineer.

c. Coating. - Forms for exposed surfaces shall be coated with a non-staining mineral oil which shall be applied shortly before the concrete is placed. After oiling the forms, the excess oil on the surfaces shall be removed by wiping with dry rags or waste. Forms for unexposed surfaces may be thoroughly wetted in lieu of oiling, immediately before the placing of concrete, except that in freezing weather oil shall be used.

d. Removal. - Forms shall not be removed without the approval of the District Engineer and all removal shall be accomplished in such manner as will prevent injury to the concrete. Forms shall not be removed before the expiration of the minimum number of days indicated below, except when specifically authorized by the District Engineer. When, in the opinion of the District Engineer, conditions on the work are such as to justify it, forms may be required to remain in place for longer periods.

Arches, beams and slabs	7 days
Columns	3 days
Walls and vertical faces	2 days

e. Form lining. - (1) In addition to the requirement for work specified above, wood forms for walls which will be visible in the finished structures, or at other locations indicated on the drawings or as directed by the District Engineer, shall be lined with plywood, or with pressed wood sheets similar to Masonite or approved equal. Lining shall be applied directly to the sheeting. The jointing of the lining shall be neat and close and no patch pieces, plugs, cleats or blocking will be permitted. Overrun of lining shall be trimmed to secure proper fit to adjoining surfaces. Lining with bruises, imprints or hammer marks shall not be used.

(2) Pressed wood sheets used for form lining shall be not less than 1/4-inch thick with a hard smooth surface on one side, and shall be specially processed to resist moisture. Sheets shall be of sizes as large as practicable to obtain a minimum number of joints. They shall be applied to the wood form construction with the smooth side against the concrete, and nailed so as to secure them properly, with all joints butted tight and bearing on solid construction. Bevels shall be formed of smooth straight-grained wood and shall be nailed through the lining into the backing. The lining shall be re-used only as many times as will insure a continuous smooth concrete finish.

8-18. Furnishing, bending, and placing steel reinforcement (Item 25).

a. Work included. - (1) The Area Engineer shall furnish, cut, bend and build into the concrete, in accordance with the drawings and directions, all reinforcing steel of deformed bars, dowels or anchors.

(2) Steel reinforcement may be cut and bent at the mill or in the field. All bending shall be in accordance with standard approved practice and by approved machine methods.

b. Materials. - Reinforcing steel shall be of new billet, intermediate grade, open-hearth steel, deformed, and shall conform to the Federal Specification QQ-B-71a for "Bars, reinforcement, concrete, Type "B", Grade 2 (dated January 12, 1938)." If available, certified copies of any mill test shall be furnished by the Area Engineer and the steel shall be subjected to such tests as the District Engineer may consider necessary to establish its quality, including particularly the requirements of bending and elongation. The steel shall be free from oil, paint, dirt or excessive rust.

c. Placing. - (1) All steel reinforcement shall be placed in the exact positions and with the spacing shown on the drawings or ordered, and it shall be so fastened in position as to prevent its becoming displaced during the placing of the concrete. The clear distance between parallel rods shall be not less than one and one-half times the diameter of round rods, or twice the side dimensions of square rods, and unless specifically authorized, shall in no case be less than 1 inch.

(2) Except where otherwise indicated, reinforcement shall be placed as follows:

(a) All main reinforcement shall be placed not less than 3 inches from any surface, for walls and similar structures embedded in earth.

(b) All main reinforcement in walls and similar structures exposed to the weather and in fire-resistant construction, shall be placed not less than 2 inches from any surface. The covering of stirrups, spacer rods and similar secondary reinforcement may be reduced by the diameter of such rods. The above dimensions shall be measured from the face of the reinforcement to the face of the forms.

(c) Where splices in reinforcement, in addition to those indicated are necessary, there shall be sufficient lap to transfer the stress by bond as may be directed. Rods shall be lapped not less than 40 diameters and splices shall be staggered. The lapped ends of rods shall be separated sufficiently or connected properly to develop the full strength of rod. Adjacent sheets of mesh reinforcement shall be spliced by lapping not less than 8 inches, the lapped ends being securely wired together.

d. Protection. - Steel for reinforcement shall be new unrusted stock, free from loose scale. It shall be at all times satisfactorily protected from moisture until placed in final position. Ends of rods that are to be left projecting for a considerable time shall be protected from corrosion by heavy wrappings of burlap saturated with bituminous material.

8-19. Embedded items. - In addition to reinforcing steel, there shall be built into, or set, or attached to the concrete, pipes and other metal objects as shown on the drawings or ordered. All necessary precautions shall be taken to prevent these objects from being displaced, broken or deformed. Before placing concrete, care shall be taken to determine that any embedded metal or wood parts are firmly and securely fastened in place as indicated. They shall be thoroughly clean and free from paint or other coating, rust, scale, oil, or any foreign matter. The embedding of wood in concrete shall be avoided whenever possible, metal being used instead. The concrete shall be packed tightly around pipes and other metal work so as to prevent leakage and secure perfect adhesion.

8-20. Expansion and contraction joints. - Expansion and contraction joints shall be constructed at such points and of such dimensions as may be indicated or required. The method and materials used shall be subject to the approval of the District Engineer and the materials shall conform to Federal specifications where applicable. Expansion joints shall be made by coating concrete surfaces with two coats of approved asphaltic emulsion or a single coat of bituminous cement and by use of a premoulded expansion joint material 1/2 inch thick. In no case shall corner protection angles or other fixed metal except copper water stops embedded in the surface of the concrete and bonded, be continuous through an expansion joint.

8-21. Measurement and credit. - a. Portland cement (Item 22). - (1) The quantity to be credited under Item 22 will be the number of barrels of cement used in all parts of the work unless specifically excepted. For purposes of credit, a barrel of cement shall be considered 376 pounds net of cement. Credit for the cement shall include payment for all expenses incidental to delivering the cement upon the work in which it is to be used.

(2) Only the cement furnished for work to be done under Items 23 and 24, will be credited under Item 22. Cement used for mortar or grout under other items will be included in the credit for those items.

b. Concrete (Items 23 and 24). - See Section IX.

c. Reinforcement (Item 25). - The quantity to be credited under Item 25 will be the number of pounds of steel reinforcement placed in accordance with the drawings or orders, measured as specified. It will not include any waste material due to the fact that the lengths supplies are too long for their purposes. The quantity credited will, however, include extra metal in laps, where authorized, due to the fact that single bars would be unreasonably long. In computing the weights, the theoretical weight of plain bars will be as tabulated in Federal Specification QQ-B-71a for the lengths placed as required. Wire or metal clips, and other supports necessary to hold the steel in place will not be considered as reinforcement but shall be furnished by the Area Engineer without additional credit allowance. Credit for Item 25 shall include the cutting, placing, fastening in position, coating, and protecting the reinforcement, and all other work and materials connected therewith (see Paragraph 8-18 a).

SECTION IX. CONCRETE STRUCTURES (Items 23 and 24)

9-01. General. - a. Description. - Concrete structures shall be constructed as shown on the drawings or as directed by the District Engineer. Concrete shall conform to all requirements of Section VIII for concrete of the class specified. Surfaces of concrete shall be finished as specified in Paragraph 8-15, except as otherwise specified in this section or indicated on the drawings.

b. Measurement and credit. - The quantity to be credited under Items 23 and 24 will be the number of cubic yards of concrete satisfactorily placed within the required limits. No deductions shall be made for openings having a cross-sectional area less than that of a 12-inch pipe, nor for the space occupied by reinforcing steel, miscellaneous metal, wood nailing strips, or by other materials required to be built into the concrete. Credit shall include all costs of furnishing materials, erecting and removing forms, mixing and placing concrete. Cement, reinforcing steel and other metal work are included under other items. (See Paragraph 8-21.)

9-02. Class "A" concrete in walls and stop-log structures (Item 23). - a. Description. - This classification includes the Class "A" concrete required for the flood wall and stop-log structures, as shown on the drawings or as directed by the District Engineer. Forms for exposed surfaces shall be lined with plywood, or with pressed wood, "Masonite," or equal. Concrete fins formed on exposed surfaces shall be removed after the forms are stripped. Miscellaneous metal work shall be set and concreted in place as provided for on the drawings.

b. Measurement and credit. - The volume of concrete to be credited under Item 23 will be the volume computed between the limiting lines and grades, as shown on the drawings or directed by the District Engineer. Credit shall include all Class "A" concrete placed under Item 23, "Class 'A' Concrete in Walls and Stop-Log Structures."

9-03. Class "A" concrete in miscellaneous structures (Item 24). - a. Description. - This classification includes the Class "A" concrete for concrete manholes and head walls, and all other Class "A" concrete in miscellaneous structures, not included in any other item, placed between the limiting lines and grades, and in the required locations, as shown on the drawings or directed by the District Engineer. Concrete fins formed on exposed surfaces shall be removed after the forms are stripped. Miscellaneous metal work, including the flanged cast iron wall pipe, shall be set and concreted in place as provided for on the drawings. Brick lining for the concrete manhole shall be furnished and placed as shown on the drawings and conforming to the applicable provisions of Paragraph 7-05.

b. Measurement and credit. - (1) The volume of concrete to be credited will be the volume computed between the limiting lines and grades, as shown on the drawings or directed by the District Engineer. Credit shall include all Class "A" concrete placed under Item 24, Class "A", Concrete in Miscellaneous Structures."

(2) Credit for all costs of furnishing and placing the brick lining for the concrete manhole will be included in the credit for Item 24, Class "A", "Concrete in Miscellaneous Structures."

(3) Credit for furnishing and installing miscellaneous metal will be made under Item 27 (see Paragraph 10-05 b), except cast iron pipe which will be credited under Items 34(a) and 34(b), (see Paragraph 11-04f(1)).

SECTION X. METALS AND EMBEDDED ITEMS (Items 26 to 28 incl.)

10-01. General. - All metals, unless otherwise specified, shall conform to applicable Federal Specifications, and, when not covered thereby, to applicable A.S.T.M. specifications. All castings shall have the pattern or mark number cast on them. Unless otherwise authorized by the District Engineer, the scale weights of each casting or forging after machining shall be within 5 per cent of the weights as calculated from the dimensions specified or shown on the drawings. Castings shall conform, at the minimum section thereof, to the following dimensional tolerances: where embedded in concrete, to within 1/8 inch; where not embedded in concrete, to within 1/16 inch of the dimensions shown on the drawings.

10-02. Materials and workmanship. - The articles included in Items 26 to 28 inclusive, other miscellaneous materials, and all metals required in the work except as otherwise specified, shall meet the requirements of the following specifications where applicable to the use intended:

(1) Structural steel; Federal Specification QQ-S-711a; shapes, plates, bars, pins and bolts shall be Class "A" and rivets shall be Class "C", unless otherwise required. Welding will be accepted only where specified or authorized, and approved only when done in accordance with the current requirements of the American Bureau of Welding.

(2) Iron castings, gray; Federal Specification QQ-I-651, class as indicated. Tensile tests and chemical analyses will not be required.

(3) Malleable iron castings; Federal Specification QQ-I-666, Type "A".

(4) Bolts, screws, and washers; appropriate Federal Specifications and current standard practice, unless otherwise specified.

(5) Wrought-iron bars and shapes; Federal Specification QQ-I-686, Grade "B".

(6) Wrought-iron pipe; Federal Specification WW-P-441, Class "A".

(7) Cast-iron pipe; A.S.T.M. Specifications A-44-04, Class "A", for soil pipe refer to Federal Specification WW-P-401.

(8) Sheet copper; Federal Specification QQ-C-501, Type V, Class "A".

(9) Valves; Federal Specification WW-V-76a, unless otherwise specified or shown on the drawings.

(10) Other items, unless otherwise specified, shall conform to current standard practice for the material required and use intended.

10-03. Galvanizing and painting. - a. Galvanized iron and steel articles shall be galvanized by the hot-dip process unless otherwise permitted. Injuries to the galvanizing shall be satisfactorily repaired. Provision shall be made for protecting threads either by counter-boring fittings, so as to cover threads or by cutting threads so as to make a very loose fit before galvanizing and carefully rerunning threads after galvanizing so as to leave a good coating all over threads. Hot galvanizing shall be of such quality as to endure at least 4 one-minute immersions in copper sulphate solution, in accordance with the requirements of the Preeco test.

b. All ungalvanized iron and steel to be exposed in the finished work shall be thoroughly cleaned and then thoroughly and evenly painted with one coat of red lead paint and two coats of an approved lead-and-oil paint to the satisfaction of the District Engineer. No painting shall be done until the condition of the surface to be painted has been approved. The paint shall be applied by either brush or spray in a neat, thorough, and workmanlike manner, and in no event shall any paint be applied in freezing, rainy, or misty weather. The paint used shall conform to the requirements of Federal Specifications of Group "T"; and samples of paint shall be submitted to the District Engineer for approval and selection.

10-04. Miscellaneous structural steel (Item 26). - a. The required structural steel items shall be furnished and installed as shown on the drawings. Miscellaneous structural steel shapes shall be provided and installed as shown on the drawings, and shall be securely anchored to the concrete structures as directed by the District Engineer.

b. Credit will be made as specified in Paragraph 10-05 b.

10-05. Miscellaneous iron and steel (Item 27). - a. Cover frame and steps for the concrete manhole, pipe sleeves and anchors shall be furnished and installed. All miscellaneous anchors shall be wrought iron.

b. Measurement and credit. - The quantities to be credited under Items 26 and 27 will be the number of pounds furnished and installed in the work. Credit will be made by the pound under Items 26 and 27, and shall include all costs of furnishing and installing the materials in accordance with the drawings and specifications.

10-06. Copper water stops (Item 28). - a. Copper water stops required for the expansion joints of concrete work shall be furnished and installed. Copper water stops used in concrete expansion joints shall be continuous, and shall be crimped. Splicing of the water stops shall be done by overlapping, soldering and brazing. Unless otherwise specified on the drawings the material shall be sheet copper conforming to Federal Specification QQ-C-501, Type "V", Class "A", weighing 20 ounces per square foot. The crimp shall be filled with a mastic filler of "elastite," as manufactured by Philip Carey Company, Cincinnati, Ohio, or equal. Copper water stops shall be placed in the expansion joints indicated on the drawings or as directed by the District Engineer.

b. Measurement and credit. - The quantity to be credited under Item 28 will be the number of pounds furnished and installed in the work. Credit will be made by the pound under Item 28, "Copper Water Stops," and shall include all costs of furnishing and installing the copper water stops in accordance with the drawings and specifications.

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SECTION XI. MISCELLANEOUS (Items 29 to 35 incl.)

11-01. Placing topsoil and sodding embankment slope (Items 29 and 30). - a. Work included. - The Area Engineer shall furnish and place topsoil on the slopes and top of the earth dike as shown on the drawings, and on other areas as required by the District Engineer. Under Item 29, acceptable topsoil shall be placed to the required depth over the required areas. Under Item 30, the prepared topsoil surface shall be sodded and seeded when and as directed by the District Engineer.

b. Placing topsoil. - After the earth dike has been completed to the proper height and dimensions, the Area Engineer shall apply the stored topsoil (see Paragraph 3-02 a(2)) or additional acceptable topsoil if necessary, to the required depth when compacted, over the slopes and top of the embankment to the limits shown on the drawings. The topsoil shall be lightly rolled or tamped and any unevenness of surface shall be corrected to conform to finished grades.

c. Sodding. - (1) The locations shown on the drawings shall be planted with living sods of Bermuda or some other acceptable grass which will best meet the climatic conditions. Sod obtained by stripping operations (see Paragraph 3-02 a(2)) may be used if approved by the District Engineer. Each sod shall have an area of not less than 16 square inches. Sod shall be placed not more than 13 inches center to center for the minimum-sized sods; larger sods may be spaced proportionately, depending on their size. The District Engineer may require certain areas to be completely sodded in strips. Sod shall be covered with one-half to one inch of earth in such manner as to protect the roots from drying out. Sod shall be placed as soon as practicable after cutting, and newly placed sods shall be kept moistened by sprinkling when and as required by the District Engineer until the completion and final acceptance of the work.

(2) Sodding shall be commenced immediately upon completion of a length of dike to final grade and cross section that will be unaffected by later construction operations, and shall be prosecuted at a rate satisfactory to the District Engineer.

(3) Seeding may be allowed by the District Engineer in lieu of sodding if in his opinion the seed resulting from seeding operations would provide better protection for the newly constructed embankments. The District Engineer may also direct that seeding shall be done to supplement the sodding operations.

d. Seeding. - (1) Preparation. - All grass or cover crop seed shall be sown at the earliest practicable date, or when directed by the District Engineer, so as to secure the greatest possible protection against erosion. The finished surface grade of the embankments shall be maintained in a true and even condition during the seed-sowing operation, and the Area Engineer shall rake the soil to a depth of three quarters of

an inch (3/4") by using iron rakes immediately previous to sowing seed. All raking shall be done in a direction parallel to the contour lines on the slope and not uphill or downhill. All sticks, stones, woods or trash appearing on the surface shall be removed.

(2) Seed mixture. - The following mixture will be approved for each acre of seeding:

Perennial Rye Grass	7 lbs.
Orchard Grass	15 lbs.
Hard Fescue	4 lbs.
Kentucky Blue	6 lbs.
Sheep Fescue	6 lbs.
Timothy	7 lbs.
Perennial Red Clover	4 lbs.
White Clover	4 lbs.
Red Top	7 lbs.

Total per acre 60 lbs.

For all seeded areas, about 15 pounds of oats per acre shall be added if the planting is done between the middle of June and the middle of September, and about 15 pounds of winter rye per acre shall be added if the planting is permitted and done in the late season after the middle of September.

(3) Method of seeding. - The Area Engineer shall take advantage of favorable weather and shall employ a method of sowing satisfactory to the District Engineer. The seed shall be raked in and the whole surface then lightly rolled the same day, unless otherwise directed by the District Engineer. Seeding shall be done immediately after the preparation of the earth surface unless otherwise directed. If there be any delay, and if weeds grow in and with the grass, such weeds shall be cut before they go to seed or at such time as directed by the District Engineer. If any loam is washed away or any portions of the seeded areas are not covered by grass, the Area Engineer shall replace the topsoil, fertilize and re-seed.

(4) Maintenance. - The Area Engineer shall maintain the areas sown to grass seed on each section of the project, until all work on that section has been completed and accepted by the District Engineer. This maintenance shall consist of occasional mowing with a scythe or mechanical mower, watering during periods of drought, and removal of large and conspicuous weeds, or any other similar operations whenever required by the District Engineer. The turf areas shall be fertilized with an acceptable commercial lawn fertilizer of a quality equal to Vigoro or Scott's lawn fertilizer at the customary quantity per acre recommended by the manufacturer.

e. Measurement and credit. - (1) The quantity of topsoil to be credited under Item 29 will be the number of cubic yards actually placed

in accordance with directions, measured after compacting. Credit shall include the costs of all labor, materials and expenses incidental to furnishing and placing the topsoil. Credit will be made by the cubic yard under Item 29, "Topsoil on Embankment."

(2) The quantity to be credited under Item 30 will be the number of acres sodded and seeded as directed. The measurement will be the actual areas sodded and seeded. Credit shall include all costs for sodding and seeding as specified in sub-paragraphs c and d above, and for all materials and expenses incidental thereto. Credit will be made by the acre under Item 30, "Sodding and Seeding."

11-02. Timber stop-logs (Item 31). - a. Work included. - Creosoted timber stop-logs shall be furnished and installed for the stop-log structures at the locations shown on the drawings or as directed by the District Engineer.

b. Materials. - (1) Creosoted timber shall be No. 1 Common plain white oak conforming with the Standard Grading and Dressing Rules of The National Hardwood Lumber Association and to Federal Specification FM-L-736, "Lumber and Timber; Hardwood." Timber shall be treated with a creosote-coal-tar-solution conforming to Federal Specification TT-W-566, "Wood-Preservative; Creosote-Coal-Tar-Solution (for) Ties and Structural-Timbers". (See Specification No. 5-b of the American Wood Preservers' Association). Timber shall be treated by the pressure process in accordance with Federal Specification TT-W-571a, "Wood-Preservative; Preservative-Treatment." The minimum absorption of preservative shall be 6 pounds per cubic foot by the empty cell treatment (see specification for treatment, American Wood Preservers' Association Specification No. 34-b).

(2) For bolts and other necessary hardware, see Section X.

c. Description. - Stop-logs with their necessary bracing shall be carefully framed to fit the stop-log structures, and shall be installed as shown on the drawings or stored as directed by the District Engineer.

d. Measurement and credit. - Measurement for credit will be based on the number of thousand feet board measure furnished and installed (or stored). Credit will be made under Item 31, "Timber Stop-Logs," and shall include all costs of furnishing and installing (or storing) timber stop-logs and incidental bracing, with all bolts, nuts, washers or other hardware necessary and proper construction and installation.

11-03. Gravel surfacing for roads (Item 33). - a. Work included. - The Area Engineer shall furnish and place gravel of the sizes and quality specified or directed for the surfacing of roadways, to the lines and grades shown on the drawings.

b. Material. - The gravel shall be composed of hard, durable stones, free from thin or elongated pieces, and mixed with sand and clay or other approved binding material. The gravel shall be of such sizes that all will pass through a screen with 3/4-inch square openings, and not less than 35 per cent will be retained on a screen with 1/4-inch square openings; and for either course it shall be uniformly graded. The finer

material shall consist of sand and clay or other binding material approved by the District Engineer. Should the material as received for the work fail to maintain suitable proportions of coarse and fine particles, or should the coarse particles not be uniformly graded between the maximum and minimum sizes as specified, it shall be screened, or mixed in such a manner as to furnish a material to meet the above requirements.

c. Placing. - (1) The gravel surfacing shall be placed in one layer of the thickness shown on the drawings, after compaction. After the subgrade or foundation has been properly prepared and compacted and proper drainage provided, the material shall be spread evenly by means of approved spreader vehicles or trucks. The material as spread shall be well-graded with no pockets of fine material or segregation of large and fine particles. After being spread evenly, the material shall be thoroughly compacted, by rolling with a self-propelled three-wheel roller weighing not less than ten tons, until a firm even surface is obtained. If at any time the material does not contain a sufficient amount of moisture to insure proper binding, water shall be added by means of a sprinkling wagon or any approved method in a sufficient amount to obtain the desired results.

(2) Rolling shall start longitudinally at the side and gradually proceed toward the center of the roadway overlapping on successive trips. During the process of rolling the material shall be dragged; the dragging and rolling shall continue until the material does not creep or wave under the roller.

d. Shoulders. - Shoulders shall be composed of gravel, practically free from loam and with all stones larger than four inches removed. Before the final completion of the work the shoulders shall be reformed, trimmed, raked and rolled.

e. Measurement and credit. - The quantity to be credited under Item 33 will be the number of cubic yards furnished and placed in accordance with the drawings or as directed by the District Engineer. The gravel surfacing will be measured in place after compacting. Credit will be made by the cubic yard under Item 33, "Gravel for Surfacing for Roads," and shall include all expenses incidental to furnishing, placing, rolling or otherwise compacting the gravel surfacing.

11-04. Cast iron pipe. (Items 34(a) and 34(b)). - a. Work included. - The Area Engineer shall furnish and place the cast iron pipe, including bends, wall sections and other specials required as shown on the drawings.

b. Materials. - All cast iron pipe shall meet the requirements of the current American Water Works Association specifications for standard weight pipe, Class A, where applicable, shall be asphalt coated inside and outside and shall have flanged or bell-and-spigot joints as shown on the drawings or as directed by the District Engineer.

c. Excavation. - Excavation will be done as shown on the draw-

ings and as provided for in Paragraph 3-03. Pipe trenches shall have the dimensions shown on the drawings. The bottom of the trench throughout its length shall be carefully formed to fit the circular shape of the pipe, so that the pipe shall be firmly supported on the bottom and for at least 2 inches up each side. Where encountered, rock or boulders shall be removed to a depth of 6 inches below the bottom grade of the trench and the voids backfilled with well compacted suitable material.

d. Laying pipe. - (1) All pipe shall be placed in the trench immediately after the excavation is completed. Proper care shall be used in handling the pipe to avoid injury. The pipe shall be carefully bedded, and properly connected and jointed. The pipes shall be laid true to the lines and grades shown on the drawings or as staked in the field.

(2) Bell-and-spigot joints shall be fully fitted together and shall be made fast by first adjusting the spigot end with wedges to obtain a uniform joint space; and then thoroughly packed with oakum or jute and caulked with lead. Before backfilling, the pipe shall be tested for leakage by a suitable water pressure test as directed by the District Engineer.

e. Backfilling. - Backfill material shall be evenly spread and compacted under and around the pipe to the limits shown on the drawings or as directed by the District Engineer. Hand tappings shall be done as directed.

f. Measurement and credit. - (1) Measurement for credit will be based on the linear feet of pipe of the size installed. Credit for pipe will be made by the linear foot under Items 34(a), "10-Inch Cast Iron Pipe and 34(b), "18-Inch Cast Iron Pipe", and shall include all costs of furnishing and installing the pipe complete with bonds, flanged wall sections and other specials, except the cost of excavation, backfilling, and any concrete required.

(2) Credit for excavation will be made under Item 4 (see Paragraph 3-05). Credit for backfilling will be made under Items 13 and 24 (see Paragraphs 6-04 d and 9-03 b) as applicable.

11-05. Cleaning up (Item 35). - a. Work included. - The Area Engineer shall remove all construction equipment and all temporary structures built or used by him, shall remove logs, rubbish of all kinds, and any other unsightly or objectionable material from the site of the work, and from any grounds which he shall have occupied within the limits of the work, and shall leave the site of the work in a clean condition satisfactory to the District Engineer. All materials salvaged shall be the property of the Government unless otherwise designated by the District Engineer.

b. Credit. - For all work, materials and incidentals required to clean up as set forth in a above, credit will be made under Item 35, "Cleaning Up."

United States Engineer Office
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